TECHNICAL MANUAL

RESPIRATORY HUMIDIFIER MODELS

MR730

MR720

MR700

MR480

Revision D

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MR700 Dual Servo
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CONTENTS PAGE

1.0 MR700 Series General Specifications 1
1.1 Electrical Specifications 1
1.1.1 Models MR730/720/700 1
1.1.2 Model MR480 1
1.1.3 Common Electrical Specifications (All Models) 1
1.2 Standards and Approvals 1
1.3 Temperature Control 2
1.4 Temperature Sensing 2
1.5 Temperature Display 2

2.0 Operating Controls And Modes 3
2.1 Adjustable Controls 3
2.1.1 Airway Temperature Control 3
2.1.2 Chamber Control (Heater Wire On Mode Only) 3
2.2 Push Switches 3
2.2.1 Mute Button 3
2.2.2 Chamber Temp Button 3
2.2.3 Standby Button (MR700/720/730 only) 3
2.2.4 Heater Wire Switch (MR720, MR730 only) 4
2.3 Power Up Sequences 4
2.3.1 Version 1.0 Software 4
2.3.2 Version 2.0 and Version 3.0 Software 4
2.4 Heater Wire On Mode (All models except MR480) 4
2.5 MR730/720 in Heater Wire Off Mode and MR480 4
2.6 Warm Up Mode 5
2.6.1 MR700/MR730 and MR720(version 1.0) in Heater Wire Mode 5
2.6.2 MR700/MR730 and MR720(version 1.0) in Non Heater Wire Mode and MR480 5
2.6.3 MR720 With Version 2.0/3.0 Software 5
2.7 Standby Mode 5
2.7.1 MR700/MR730 and MR720 (Version 1.0) Only 5
2.7.2 MR720 Standby Mode (Version 2.0 and 3.0 software only) 5

3.0 Alarms and Indicators 6
3.1 Temperature Probe Alarm 6
3.2 Alarms In Heater Wire Mode (MR700/720/730 only) 6
3.2.1 Heater Wire Alarm 6
3.2.2 Airway temperature High Alarm 6
3.2.3 Airway temperature Low Alarm 7
3.2.4 Chamber Temp High Alarm 7
3.2.5 Chamber Temp Low Alarm 7
3.2.6 Set Low Warning 7
3.3 Temperature Alarms in Non Heater Wire Mode (includes MR480) 8
3.3.1 Heater Wire Alarm 8
3.3.2 Airway Temperature High Alarm 8
3.3.3 Airway Temperature Low Alarm 8
3.4 Audio Alarm 8
3.5 Safety Protection (All Models) 8
3.5.1 Temperature Deviations 8
3.5.2 Microprocessor Watch Dog 8

4.0 Circuit Operation 9
4.1 Introduction 9
4.2 Control Board 9
4.2.1 Control Thermistors 9
4.2.2 Input Analog Switches U8 and U9 9
4.2.3 Analog to Digital Converter U10 b,d,e 9

CONTENTS **PAGE**

4.2.4 Processor Control U3 9
4.2.5 Power Line Interrupt (Revisions D/F PCBs) 10
4.2.6 Power Line Interrupt (Revision H PCB) 10
4.2.7 41 °C Comparator 10
4.2.8 Heater Plate Overtemperature 10
4.2.9 Watch Dog 10
4.3 Power Board 11
4.3.1 Revision D/F PCBs 11
4.3.2 Revision H PCBs 11
4.4 Probe Temperature versus Thermistor Resistance 12

5.0 Calibration 13
5.1 Introduction 13
5.2 Equipment Required 13
5.3 Calibration Procedure for Models with Revision D PCBs or earlier 13
5.4 Calibration Procedure for Models with Revision F PCBs or later 14

6.0 Performance Check 15
6.1 Introduction 15
6.2 Performance Check MR730/720/700 15
6.2.1 Equipment Required 15
6.2.2 Static Test Sequence (MR730/720/700) 15
6.2.3 Dynamic Test Sequence (MR730/720/700) 16
6.3 Performance Check (MR480) 17
6.3.1 Equipment Required 17
6.3.2 Static Test Procedure (MR480) 17
6.3.3 Dynamic Test Procedure (MR480) 18
6.4 Dual Probe Temperature Test 19
6.4.1 Equipment Required 19
6.4.2 Test Procedure 19

7.0 Servicing Information 20
7.1 Introduction 20
7.2 Printed Circuit Board Removal 20
7.2.1 Control PCB 20
7.2.2 Power PCB 20
7.3 Replacement of Revision D Power & Control PCB Assemblies 20
7.4 Heater Plate 21
7.5 Fault Location 21
7.6 Screw Torque Settings 21

8.0 Schematics, Part Lists and Mechanical Drawings 23
8.1 MR700 Series Circuit Layout Block Diagram 23
8.2 Component Layout - Revision H PCB 25
8.3 Component Layout - Revision F PCB 27
8.4 Component Layout - Revision D PCB 29
8.5 Link Pad Locations for Programming Control Options - Revision H PCB 31
8.6 Circuit Diagrams - Revision H PCB Control PCB 33
Circuit Diagrams - Revision H PCB.Power PCB 34
8.7 Circuit Diagrams - Revision F PCB Control PCB 35
Circuit Diagrams - Revision F PCB Power PCB 36
8.8 Circuit Diagrams - Revision D PCB Control PCB 37
Circuit Diagrams - Revision D PCB Power PCB 38
8.9 Electrical Parts List 39
8.9.1 Control Board Components: (Revision H PCB) 39
8.9.2 Power Board Components: (Revision H PCB) 40

8.10 Mechanical Parts List 41
8.10.1 MR480 Mechanical Parts 41
8.10.2 MR730/720/700 Mechanical Parts 42
8.10.3 Heater plate Assembly Parts (MR730/720/700/480) 43
8.11 Exploded Diagrams: MR480 45
8.11 Exploded Diagrams: MR730/720/700 47
8.12 *Exploded Diagrams:Heater plate Assembly MR730/720/700/480 (Inverted View)* 49
8.13 PCB Identification Diagram 51
8.14 Power PCB Harness Connection Diagram 53

9.0 Product Change History 55
9.1 Compatibility of Software and Hardware Versions 55
9.2 Model Number Explanation 56
9.3 Serial Number Explanation 56

Appendix A 57
A1 Calibration Mode 57
A2 Engineering Menu 57
A2.1 Engineering display functions: Heater Wire Mode 57
A2.2 Engineering Functions: Non Heater Wire Mode 58
A2.3 Integral Display 58
A3 Programming Control Options 58
A4 Glossary of Abbreviations 58
A5 Error Codes 58
A6 MR700 Series Humidifier Serial Data Interface 59
A6.1 Serial Data Format 59
A6.2 Status Information 60
A6.3 Remote Standby 61
A6.4 Serial Data Interface Connector 61
A7 Revision F & H PCB Schematic Diagrams 61

Appendix B 62
B1 Recommended Maintenance Schedule 62
B2 Recommended Maintenance Schedule Checklist 63

Appendix C 65
C1 Troubleshooting Guide For The MR700 Series Respiratory Humidifiers 65
C2 MR700 Series Fault Flow Chart For No Go Condition 68

1.0 MR700 Series General Specifications

This documentation defines the technical specifications of the MR730, MR720, MR700 and MR480 respiratory humidifiers.

The MR730/720 models are Heated Wire humidifiers with the option of disabling the Heater Wire. The MR720 has a lower alarm limit and an extended warmup mode for use in Anaesthesia.

The MR700 model is exclusively a Heated Wire humidifier.

The MR480 model is a non Heated Wire humidifier.

1.1 Electrical Specifications

1.1.1 Models MR730/720/700

Supply Voltage:	230V ± 25V 127V ± 12V 115V 100V ± 10V
Supply Frequency:	50 - 60 Hz
Supply Current:	1.0 A maximum at 230V 1.9 A maximum at 127V 2.0 A maximum at 115V 2.4 A maximum at 100V
Heater Wire Capacity:	60 W

1.1.2 Model MR480

Supply Voltage:	230V ± 25V 115V 100V ±10V
Supply Frequency:	50 - 60 Hz
Supply Current:	0.7 A maximum at 230V 1.4 A maximum at 115V 1.6 A maximum at 100V

1.1.3 Common Electrical Specifications (All Models)

Heater Plate Power:	150 W
Heater Plate Overheat Protector:	Operates at 118 °C ± 6 °C

1.2 Standards and Approvals

Classification under	UL544, CSA-C22.2 No.125 IEC601-1, AS3200.1, BS5724:Part 1, DIN VDE 0750 Teil 1
	Class 1 Type B Drip Proof Continuous Operation Not to be used in the presence of flammable anaesthetics.

1.3 TEMPERATURE CONTROL

PID (Proportional Integral Derivative) control of Heater Wire (in Heated Wire mode operation only) and heater plate.

1.4 TEMPERATURE SENSING

Temperature measurement using standard characteristic thermistors (YSI 400 compatible) mounted in fast response temperature probes, located at the patient end of the delivery tube and at the humidifying chamber outlet.

1.5 TEMPERATURE DISPLAY

Three digit 14mm 7 segment LED (Light Emitting Diode) display.
Range 5.0 to 80.0 degrees. Below 5.0 degrees displays 'Lo'. Above 80.0 degrees displays 'Hi'.
Accuracy 25.0 to 45.0 degrees ± 0.3 degree.

2.0 OPERATING CONTROLS AND MODES

2.1 ADJUSTABLE CONTROLS

2.1.1 AIRWAY TEMPERATURE CONTROL

Selects the airway controlling temperature. The range of adjustment is from 29 to 40 °C over a linear scale marked in degrees on the front panel.
The temperature can be set with a resolution of 0.1 °C. The set temperature is flashed on the display when the control knob is rotated and continues to be flashed for five seconds after the last adjustment.

2.1.2 CHAMBER CONTROL (HEATER WIRE ON MODE ONLY)

The temperature of the gas leaving the chamber is regulated by the Chamber Control knob, it sets the difference between the chamber outlet temperature and the airway temperature delivered to the patient. The setting of the Chamber Control, when added to the setting of the Temperature Control, determines the chamber outlet set temperature. This Chamber Control has a linear range of adjustment from -5 to +2 °C marked in one degree steps and can be set with a resolution of 0.5 °C. The value is flashed on the Airway display as the control knob is rotated and continues to be flashed for five seconds after the last adjustment.

Every humidifier is also supplied with a fixed chamber control knob. This prevents inadvertent adjustment of the chamber control by preadjusting the existing knob to the desired setting and then replacing the normal knob with the fixed knob.

2.2 PUSH SWITCHES

2.2.1 MUTE BUTTON

A momentary push will disable an audible alarm for 3 minutes (except low temperature alarm in non heater wire mode which is ten minutes).
A secondary function is that in conjunction with the Chamber Temp switch enables entry to the engineering menu (refer Appendix A2).
On every initial push of the mute button a momentary audio beep indicates function operation.

2.2.2 CHAMBER TEMP BUTTON

For MR700 Series Humidifiers with Version 1.0 Software:
Operation of this switch causes the airway temperature display to momentarily blank then show the chamber outlet temperature. A green LED adjacent to the switch is enabled to indicate that this function is active. On release of this switch the display reverts immediately to show the airway temperature.
This button is used in conjunction with the mute to enter the engineering menu (refer Appendix A2).

For MR700 Series Humidifiers with Version 2.0 and Version 3.0 Software:
Operation of this switch causes the airway temperature display to momentarily blank then show the chamber outlet temperature. A green LED adjacent to the switch is enabled to indicate that this function is active. On release of this switch the display continues to show the chamber outlet temperature for 2 seconds before blanking momentarily and reverting to show the airway temperature.
This button is used in conjunction with the mute to enter the engineering menu (refer Appendix A2).

2.2.3 STANDBY BUTTON (MR700/720/730 ONLY)

This button has to be depressed for one second to enter or exit the standby mode. When the adjacent amber LED starts to flash (100/minute) the button can then be released and the Humidifier remains in the standby mode.

To exit Standby mode press the Standby button for 1s, the amber LED will then turn off. An audio beep accompanies a change in the Standby mode state.

2.2.4 HEATER WIRE SWITCH (MR720, MR730 ONLY)

This is a latching, push operated, switch which selects between the heater wire mode and non-heater wire mode. The adjacent green LED, if on, indicates that the humidifier is operating in the heater wire mode. Pressing this switch will cause an audible beep and the LED changes to indicate the new state. A heater wire alarm will commence if switching to the heater wire mode with no heater wire connected or if switching to the non heater wire mode if a heater wire is connected.

2.3 POWER UP SEQUENCES

2.3.1 VERSION 1.0 SOFTWARE

After switch on the humidifier goes through the following sequence. Note that each displayed information is flashed for 2 seconds.

- Watchdog circuit test — If successful the 'SEE MANUAL' LED lights briefly.
- Display Test — All indicator LEDs are illuminated and '8.8.8.' is displayed on the Airway Temperature display
- Temperature Control Setting — eg '37.0' is displayed
- Chamber Control setting — If heater wire mode is selected then the chamber control setting is displayed eg '-1.0'. Not applicable for MR480
- Software Version Number — '1.0'
- Maximum Heater Plate Setting — eg '110'
- Audio Beep

2.3.2 VERSION 2.0 AND VERSION 3.0 SOFTWARE

After switch on the humidifier goes through the following sequence. Note that each information is displayed for 2 seconds, then the display is momentarily blanked.

- Watchdog circuit test — If successful the 'SEE MANUAL' LED lights briefly.
- Display Test — All indicator LEDs are illuminated and '8.8.8.' is displayed on the Airway Temperature display
- Model Number — eg '730'
- Software Version Number — eg '2.0'
- Temperature Control Setting — eg '37.0' is displayed
- Chamber Control setting — If heater wire mode is selected then the chamber control setting is displayed eg '-1.0'. Not applicable for MR480
- Maximum Heater Plate Setting — eg '110'
- Audio Beep

2.4 HEATER WIRE ON MODE (ALL MODELS EXCEPT MR480)

In the Heater Wire On Mode (heater wire switch green LED on) the heater plate and heater wire are regulated to maintain the desired temperature and humidity, within close limits with a minimum of condensation. To minimise rainout or maximise humidification, the chamber outlet temperature can be adjusted to control at a fixed offset from the set airway temperature. The front panel Chamber Control knob is used for this purpose, see 2.1.2 above.

2.5 MR730/720 IN HEATER WIRE OFF MODE AND MR480

In the non Heater Wire mode of the MR730/720 (heater wire switch green LED off) the delivery temperature is maintained by heater plate control only. The sensor at the delivery hose end controls the heater plate to deliver the selected temperature. The sensor at the chamber outlet is employed in a backup safety mode, to limit the chamber outlet temperature to a maximum of 66 °C. In this way safety at low flow rates (below 5 L/minute) is enhanced at the sacrifice of some low flow performance.

2.6 WARM UP MODE

The Low temperature alarm is disabled during warm up. It is enabled as soon as any of the following conditions are met:

2.6.1 MR700/MR730 AND MR720(VERSION 1.0) IN HEATER WIRE MODE

- the airway temperature gets within 0.8 degrees of the temperature control setting.
- the airway temperature does not increase by 2 °C within 4 minutes (2 minutes for version 3.0 software)
- the airway temperature does not get within 2 °C of the set point within ten minutes of switch on.

2.6.2 MR700/MR730 AND MR720(VERSION 1.0) IN NON HEATER WIRE MODE AND MR480

- the airway temperature gets above 30 °C
- the airway temperature does not increase by 2 °C within 15 minutes
- the airway temperature increases by 2 °C within 15 minutes but still has not reached 30 °C after a further 15 minutes.

Note:- In this mode the audio alarm is not enabled for 30 seconds after the Airway Temp Low LED switches on. At this time the heater plate circuit switches off.
And a low temperature alarm mute is for 10 minutes, during which the heater plate is enabled.

2.6.3 MR720 WITH VERSION 2.0/3.0 SOFTWARE

If the above warm up conditions are not initially met the MR720 will automatically enter the standby mode for 20 minutes for version 2.0 software and 30 minutes for version 3.0 software (refer 2.7).

2.7 STANDBY MODE

2.7.1 MR700/MR730 AND MR720 (VERSION 1.0) ONLY

The standby mode can be entered or exited by depressing the standby button for 1 second. A beep will be emitted once successful entered or exited standby mode (refer 2.2.3)

In the standby mode all Low Temperature alarms are inhibited, the heater plate is controlled to a nominal 40.0 °C and the heater wire is on a 15% duty cycle.
Standby mode is automatically exited after 20 minutes (30 minutes for version 3.0 software) and the warm up mode is entered (the low temperature alarms remain disabled - refer section 2.6).

A Remote Standby request (see Appendix A6.3) enables the standby mode and turns the standby amber LED permanently on.

2.7.2 MR720 STANDBY MODE (VERSION 2.0 AND 3.0 SOFTWARE ONLY)

The MR720 has a special feature where it will go into a standby mode automatically after turn on if the warm up conditions are not met. This standby mode time is 20 minutes for version 2.0 and 30 minutes for version 3.0

While in standby mode:
a) If the airway temperature increases by 2 °C at any time, the MR720 will exit stand by mode and enter warm up mode. The unit then rechecks warm-up exiting conditions and if these are not met, then the unit re-enters Standby mode.
b) If the airway temperature has not increased by 2 °C or come within 2 °C of the set temperature by completion of the standby period, initial warm-up resumes. The unit then rechecks warm-up exiting conditions and if these are not met, the unit alarms.

3.0 ALARMS AND INDICATORS

3.1 TEMPERATURE PROBE ALARM

If the airway temperature probe is disconnected or develops a low or high resistance the Temperature Probe alarm will be enabled. Indication is by a '- - -' message on the airway temperature display plus a flashing Temperature Probe red LED and an audio alarm.
Five specific fault types can be diagnosed and are displayed by the sequence of 'decimal points' in the display, as shown below:

(a) - - - Temperature Probe not plugged in.
Low temperature (~0 °C)
Open circuit chamber outlet probe
Open circuit in common lead in probe cable.

(b) - - -. Open circuit patient airway probe
Very low temperature (~0 °C)

(c) - -.- Short circuit chamber outlet probe
Very high temperature (~100 °C)

(d) - -.-. Short circuit patient airway probe
Very high temperature (~100 °C)

(e) -.- - Short in probe cable between patient airway probe and chamber outlet probe

The faults (a to d) above are checked for at a rate of about twice per second. The final fault (e) which does not immediately cause any apparent operating anomaly is checked twice a minute.
A Temperature Probe Alarm immediately shuts down both heater wire and heater plate.
Once the alarm condition has been removed the humidifier will enter warm up mode (refer section 2.6).

3.2 ALARMS IN HEATER WIRE MODE (MR700/720/730 ONLY)

3.2.1 HEATER WIRE ALARM

If the heater wire is disconnected or there is a fault with the heater wire circuit, then the Heater Wire alarm LED will start flashing and the audio alarm will be enabled. Both heater wire and heater plate circuits will be shutdown. The display will continue to indicate the temperature sensor reading (unless the heater wire fuse is open circuit).

An open circuit heater wire fuse is indicated by 'F-2' appearing on the Airway Temperature display.

On MR720/730 if the Heater Wire is connected but switched off, the alarm will sound (refer section 2.2.4).

Note:
If 'F-2' is displayed and the F2 fuse is intact then check the calibration of the 41°C overheat (refer section 5).

3.2.2 AIRWAY TEMPERATURE HIGH ALARM

The red Airway Temp High LED will flash and an audible alarm will sound if the gas temperature being delivered to the patient is 2°C higher than the Temperature Control setting. A high temperature alarm instantly disables both heater circuits.

3.2.3 AIRWAY TEMPERATURE LOW ALARM

The red Airway Temp Low LED will flash and an audible alarm will sound if the gas temperature being delivered to the patient is 2°C lower (4°C for MR720 model) than the Temperature Control setting.

Notes:
If Airway Temperature Low alarm condition persists for more than 100 seconds the heater plate and heater wire circuits will switch off. Pressing the mute button will silence the Audio alarm and resume heat for a further 100 seconds, the Airway Temperature Low LED will continue to flash..

This alarm is disabled during warm-up, see section 2.6.1.

3.2.4 CHAMBER TEMP HIGH ALARM

This alarm will activate if:

1) The temperature of gas leaving the humidification chamber outlet is more than 4 °C higher than the chamber set temperature for more than 20 minutes. (The chamber set temperature is the sum of the Temperature Control setting and the Chamber Control setting).
2) The temperature of the gas leaving the humidification chamber outlet exceeds the chamber set temperature by 10 °C or more.

This alarm causes the heater circuits to switch off and the Chamber Temp High amber LED indicator to start flashing. The audio alarm (which can be muted) is also enabled. This alarm remains active until the high temperature condition is cleared.

3.2.5 CHAMBER TEMP LOW ALARM

This alarm will activate if:

For Chamber Set Temperature < 35°C
The temperature of gas leaving the humidification chamber outlet is less than 4°C lower than the chamber set temperature for more than 20 minutes.

OR
For Chamber Set Temperature ≥ 35°C
The temperature of gas leaving the humidification chamber outlet is less than 31°C for more than 20 minutes.

THEN:
The Chamber Temp Low alarm amber LED will begin to flash and the audio alarm (which can be muted) is enabled. This alarm remains active until the low temperature condition is cleared. Pushing the mute button will silence the Audio alarm.

3.2.6 SET LOW WARNING

Version 1.0 and Version 2.0 Software
This alarm will activate if the chamber set temperature is below 31.0 °C. In this case the Set Low amber LED will immediately be enabled and remain on, until such time as the chamber set temperature is adjusted above 31.0 °C. There is no audible alarm.

Version 3.0 Software
This alarm will activate if either the chamber set temperature or Temperature control setting is below 34.0°C.
In these cases the Set Low amber LED will immediately be enabled and remain on, until such time as the set airway or chamber temperature is adjusted above 34.0 °C. There is no audible alarm.

3.3 TEMPERATURE ALARMS IN NON HEATER WIRE MODE (INCLUDES MR480)

3.3.1 HEATER WIRE ALARM

This indicates that a heater wire has been connected when the non heater wire mode has been selected (Heater Wire On LED is off). In this case the Heater Wire alarm LED will be flashing, the audio alarm begins and the heater plate is switched off.

3.3.2 AIRWAY TEMPERATURE HIGH ALARM

The red Airway Temp High LED will flash and an audible alarm will sound if the gas temperature being delivered to the patient is 41°C or higher. Power to the heater plate is immediately shut off.

3.3.3 AIRWAY TEMPERATURE LOW ALARM

The red Airway Temp Low LED will flash and an audible alarm will sound if the gas temperature being delivered to the patient is 29.5 °C or less.
Notes:
The audio alarm is not enabled for 30 seconds after the low temperature LED begins flashing.
Pushing the mute button disables the audio alarm and restores power to the heater plate for ten minutes, the Airway Temp Low LED will continue to flash.

This alarm is disabled during warm-up, see section 2.6.2.

3.4 AUDIO ALARM

A choice of the ISO draft standard audio alarm or a gliding tone can be selected by the programming control link (L1), refer Appendix A3.
A momentary depression of the mute button will silence the audio alarm for about 3 minutes (except for a low temperature alarm in no heater wire mode, see 3.3.3. The relevant LED indicators remain flashing until the alarm condition clears. Any new alarm condition occurring within a mute delay will cause the audio alarm to be re-enabled.

3.5 SAFETY PROTECTION (ALL MODELS)

3.5.1 TEMPERATURE DEVIATIONS

An over temperature alarm condition causes an immediate shut down of both heater circuits. In the case of a Low Temperature alarm, pressing Mute causes heating to recommence, the Low Temperature LED however remains on until the fault has cleared.

There are two independent backup over temperature protection circuits.
Firstly, an over temperature protection circuit independent of the microprocessor control continuously monitors the airway thermistor sensor. This backup protection is preset to disconnect the heating circuits at 41.0 degrees.
Secondly, a bimetallic thermostat fixed to the heater plate operates if the heater plate temperature exceeds 118 °C ± 6 °C and opens the mains active supply. On cooling, this protector can only be reset by gaining access to the under surface of the heater plate and manually depressing the red reset button.
Heater plate temperature is limited to 110 °C max during normal operation (80 °C for MR720). Optional heater plate limits of 50, 80 and 90 °C can be selected. (Refer Appendix A3.)

3.5.2 MICROPROCESSOR WATCH DOG

A control loop in the operating software continuously monitors for correct operation. Should a fault be detected a hardware reset circuit attempts to re-initialise the microprocessor. If this is not successful additional hardware disables the heating circuit, blanks the display and turns the Humidifier Fault red LED on.
The watch dog circuit is tested at turn on by deliberately halting the processor and forcing initialisation.

4.0 CIRCUIT OPERATION

4.1 INTRODUCTION

This section describes briefly the operation of each of the circuit sections. Refer to the circuit diagrams in Sections 8.6 to 8.8.

4.2 CONTROL BOARD

The one basic control board, with various discreet hardware changes, provides the controlling functions for the MR730/720/700/480 range of humidifiers. Each model however is controlled by a unique software version.

4.2.1 CONTROL THERMISTORS

Three standard characteristic thermistors control all temperature functions. Two thermistors are used in a dual temperature probe sensor, another thermistor monitors the heater plate temperature.

1. A thermistor is mounted in a probe at the end of the delivery hose to measure delivered airway temperature (connector J4-1,3). This temperature is indicated by the digital display on the humidifier front panel.
2. A second thermistor mounted in a probe measures the chamber temperature at the top of the humidifying chamber (connector J4-2,3). In heater wire mode this thermistor is used to monitor and control the chamber outlet temperature.
3. A third thermistor is permanently mounted in intimate contact with the heater plate (HP) (connector J3-1,3). This prevents excessive heater plate temperatures during a warm up cycle.

4.2.2 INPUT ANALOG SWITCHES U8 AND U9

The 1 by 8 analog switch (U8) selects under processor control (PB0-3) various input signals and reference potentials. Selected sequentially are potentials giving; (0-3): the position of the temperature set potentiometer VR3, and offset potentiometer VR2. (4-6): calibration temperatures of 9, 34.5 and 60 °C across resistors R18, R17 and R16, and from (7): the heater plate (HP) thermistor.

From the 3 by 2 analog switch (U9) under processor control (PB4-6) the airway temperature and the chamber outlet temperatures from the dual probe temperature sensor are also read.

4.2.3 ANALOG TO DIGITAL CONVERTER U10 B,D,E

The temperature probe inputs are filtered by the C30, C31, R28, R26, C19, C20 network for EMI suppression. The selected output of the analog switch network U8, U9 is fed to pin 10 of U10d, a low pass operational amplifier with a gain of 11. This stage is filtered with C23 to give protection from any voltage transients appearing at its input. The integrating stage U10b rests for most of the time (50-60ms) with R35 connected (through an analog switch in U9) across the integrating capacitor C22 holding it in a discharged state. With VR5 and R34 connected to the non-inverting input of U10b the stage has a 'static' gain of about 0.5 giving a resting level of about -2.5 to -3 volts at the output pin 1.

Under processor control (PB6) when the switch section of U9 across C22 is opened the output of U10b ramps up (0.1-5ms). This rising ramp voltage is fed via R36 to the comparator stage U10e where it is referenced via R41 to the output voltage level of U10d. When the ramp voltage exceeds the threshold level of U10d the output of the comparator stage U10e switches high. This fast rising edge, assisted by the speed up capacitor C24, is fed to the RST 6.5 interrupt input of U3.

4.2.4 PROCESSOR CONTROL U3

After selecting one of the 10 input signals through the switch network of U8, U9 there is a 50-60ms pause to allow U10d to settle. At this point the switch across the integrator U10b is opened initiating a linear ramp output and the 14 bit counter in U4 is started. Within a time period of 100ns to 5ms the ramp will cause a RST6.5 interrupt to occur. The processor on responding to the interrupt, first stops

the counter, then closes the switch across the integrator readying it for the next cycle. The input switch network U8, U9 can now be stepped to the next input. The 14 bit counter can now be read and its value equated to the input signal. In this way all 10 input channels are continuously scanned. VR5 is set during calibration to give the desired ramp rate. Thus all points are scanned once every 500-600ms, self calibration performed, and the digital display updated.

4.2.5 POWER LINE INTERRUPT (REVISIONS D/F PCBS)

A sample of the power supply frequency is derived from the power transformer 22Vac secondary via R56 and Q1, buffered by Schmitt trigger U5f and fed to the RST7.5 interrupt of U3. The operating software determines the supply frequency facilitating the generation of a real time clock and also enabling a zero crossing detector for triac switching. The ADC is also phase synchronised with the line frequency thus eliminating any common error from this source.

4.2.6 POWER LINE INTERRUPT (REVISION H PCB)

The zero crossing is derived from the 10Vac secondary. Resistor R61 ensures that the secondary is ground referenced when the diodes D13 - D16 are not conducting. Network R1, R69, and C2 removes any unwanted noise from the zero crossing circuit. The operating software determines the supply frequency facilitating the generation of a real time clock and also enabling a zero crossing detector for triac switching. The ADC is also phase synchronised with the line frequency thus eliminating any common error from this source.

4.2.7 41 °C COMPARATOR

Operational amplifier U10c is a protection circuit to sense excessive delivery temperature rise. The non inverting input pin 5 is connected directly (via connector J4-1) to the patient airway thermistor. The inverting input goes to an adjustable divider network R32, VR4, R33. VR4 is set during calibration to ensure that the output pin 7 of U10c is low above an input temperature of 41 °C. This low output (OVHT) is fed via the isolating diode resistor networks D19, R55 and D20, R61 to clamp the bases of switching transistors Q10 and Q12. In this way, a patient airway temperature greater than 41°C causes both heaters to be shut down.
A watch dog failure, which is a high output from U5g, is communicated via isolating diode D11 and resistor R31 to the inverting input of U10c. This also ensures that both heater control circuits are clamped off in the event of a processor crash.

4.2.8 HEATER PLATE OVERTEMPERATURE

Thermistor HP senses the heater plate temperature. Should the heater plate exceed the maximum heater plate limit (default 110 °C) during normal operation, power to the heater plate is discontinued until it cools below this limiting temperature. Under certain operating conditions, for increased safety, lower maximum heater plate temperatures can be selected. (See Appendix A3: Programming Control Options.) Also mounted on the heater plate is a mechanical 118 °C cut out which will give protection should the electronic control system fail. This mechanical cut out is connected in series with the power transformer primary and thus causes complete shut down of the humidifier should a serious fault develop. The mechanical cut out must be manually reset by means of the reset button located on the underside of the heater plate module.

4.2.9 WATCH DOG

During operation the processor is continually monitored for correct function. This is done by changing the state of output port PB7 of U4 every 16.6 or 20ms (power line frequency interrupt). This square wave, buffered by U5b, is fed to the charge pump circuitry C16, D4, D5 and C15 which ensures that pin 13 of U5g is held hard up. Should this square wave be interrupted for any reason, C15 will discharge through R3 giving a high output from pin 12, which drives the trap interrupt input of U3. This high trap input forces re-initialisation of the processor which may or may not be successful depending on the nature of the fault. The purpose of this is to ensure that if the processor should fail, and is unable to re-initialise, it fails in a safe mode. The watch dog circuit is tested every time the humidifier is turned on by deliberately halting program execution and waiting for initialisation via the watch dog. To indicate that the processor has failed the high output of U5g also turns on Q3 which lights the 'see manual' LED10 and also turns off the display I.C. U7 to blank the digital display.

4.3 POWER BOARD

4.3.1 REVISION D/F PCBS

A bridge rectifier (D13-D16) supplies power to the 5 volt regulator Q7 mounted on the heat sink. This circuit is protected by a 1 Amp fuse (F1) mounted on the circuit board. The 5 volt negative supply stabilized by Q8, is derived from the voltage doubling network D17, D18.

The Heater Wire (HHC) is controlled by triac Q9 which is mounted on the heat sink. Q9 is switched by the optoisolator U11 which in turn is driven by Q10. Q10 is controlled directly from an output port of U4 on the control board.

The resistor R52 connected to the anode of Q9 provides a signal through (HHS) to U5d and U4. This signal, with processor interpretation, provides the information to determine if the Heater Wire is connected or open circuit and also the integrity of fuse F2, the 4 Amp fuse supplying power to the Heater Wire.

Triac Q11 (mounted on the heatsink) is controlled by optoisolator U12, which in turn is controlled by Q12, and HPC.

Transistors Q5 and Q6 are a RS232 level driver for the serial data interface.

4.3.2 REVISION H PCBS

A bridge rectifier (D13-D16) supplies power to the 5 volt regulator Q7 mounted on the heat sink. This circuit is protected by a 1 Amp fuse (F1) mounted on the circuit board. The 5 volt negative supply stabilized by Q8, is derived from the voltage doubling network D17, D18.

The Heater Wire (HHC) is controlled by triac Q9 which is mounted on the heat sink. Q9 is switched by the optoisolator, U11, which in turn is driven by Q10. Q10 is controlled directly from an output port of U4 on the control board (HHC). Resistor R9, C6 form a snubber on the triac. Capacitors C8, C32 balance the heater wire with respect to ground.

Heater wire sensing is accomplished through the optoisolator U13 and associated components R51, R52, D21, R66 and R67. R51 and R52 limit the current through the LED when the triac is on or off. With the triac off and a heater wire connected then the optoisolator will remain off. Otherwise if a heater wire is not connected then the optoisolator will be turned on and off in synchronisation with the secondary cycle. The output of the optoisolator feeds U4 on the control board. This signal, with processor interpretation, provides the information to determine if the Heater Wire is connected or open circuit and also the integrity of fuse F2, the 4 Amp fuse supplying power to the Heater Wire.

Q11 controls power to the heater plate and is under control of optoisolator U12 and transistor Q12 via an output port (HPC) on U4 on the control board. Resistors R64, R57 limit the gate current to the triac and with C33 form a snubber for the triac and the optoisolator.

Transistors Q5 and Q6 are a RS232 level driver for the serial data interface.

4.4 PROBE TEMPERATURE VERSUS THERMISTOR RESISTANCE

TEMP (°C)	RESISTANCE (Ohms)	TEMP (°C)	RESISTANCE (Ohms)
0	7352.8	36	1411.3
9	4702.2	37	1355.0
28	1976.6	38	1301.0
29	1893.3	39	1249.2
30	1814.4	40	1199.6
31	1739.2	41	1152.3
32	1667.2	42	1107.3
33	1598.2	43	1064.5
34	1532.9	44	1023.1
35	1470.6	60	560.3

5.0 CALIBRATION

5.1 INTRODUCTION

Calibration should be performed after any servicing involving the printed circuit boards. After calibration, perform a performance check as outlined in section 6.0.

Note: For instructions on disassembly of the unit, refer to Section 7.0 Servicing Information.

Calibration is facilitated by entering a special Calibration mode. See Appendix A1.
There are only two adjustments VR4 and VR5, the 41 °C comparator stage and the setting of the span of the A to D converter.

This calibration procedure may be carried out if the unit is thought to be out of calibration (E0x-E7x error messages in the display) or if any of the circuit boards have been replaced or repaired. In particular any repair that may have altered the potential of the +5 or -5 volt rails or component change associated with the A to D converter would require a calibration check.

Calibration should be checked and performed after the unit has been running for at least half an hour; ie calibration performed after the unit has warmed up.

5.2 EQUIPMENT REQUIRED

1) 41 °C calibration probe, available in MR700 series calibration kit (F & P part no. 900MR548).

Models Before Serial Number 92XXAAA05495 (Revision D PCB and earlier)

2) Heater Wire module.
3) For MR480 only - jumper connector cable, which consists of two easy hooks connected in series with a 100mm length of cable and a 22K resistor.

5.3 CALIBRATION PROCEDURE FOR MODELS WITH REVISION D PCBS OR EARLIER

(See product change history - section 9.0 for serial number details).

1) With models MR730/720/700 ensure that a Heater Wire module is connected, and that the Heater Wire switch is on (Heater Wire On LED should be on).

2) Plug in the 41 °C calibration probe.

3) Gain access to the adjustment potentiometers VR4 and VR5, by removing the control board from the humidifier front panel.

4) With model MR480 only connect the jumper cable from pin 7 of U10 to the cathode end of D7 on the control board.

5) With the Chamber Temp button held down turn on the power switch. Display should show -1-

6) Using the Chamber Temp button step through to number -4-

7) Adjust VR4 slowly so the display just changes from vertical to horizontal bars (||||| to ═══). Back off VR4 and recheck that VR4 is not rotated past this display transition point.

8) Using the Chamber Temp button step to number -5-

9) Remove the 41 °C calibration probe.

10) Adjust VR5 for a display reading of zero. (0)

11) Calibration is complete; do performance check (section 6.0).

5.4 CALIBRATION PROCEDURE FOR MODELS WITH REVISION F PCBS OR LATER

(See product change history - section 9.0 for serial number details)

1) Plug in the 41 °C calibration probe.

2) Gain access to the adjustment potentiometers VR4 and VR5, by removing the control board from the humidifier front panel.

3) With the Chamber Temp button held down turn on the power switch. Display should show -1-

4) Using the Chamber Temp button step through to number -4-

5) Starting with a vertical bar display adjust VR4 so the display changes to an all 8 display. If VR4 is rotated too far the display becomes all horizontal bars (‖.‖.‖. thru 8.8.8. to ═). The correct point is where all the segments of the all 8 display are of equal brightness.

6) Using the Chamber Temp button step to number -5-

7) Remove the 41 °C calibration probe.

8) Adjust VR5 for a display reading of zero. (0)

9) Calibration is complete; do performance check (section 6.0)

6.0 PERFORMANCE CHECK

6.1 INTRODUCTION

This procedure may be used to check the operation and calibration of the MR730/720/700/480 humidifiers without dismantling the unit. This performance check should be performed after any servicing involving the printed circuit boards, and annually as part of the routine maintenance procedure (see Appendix B).

Performance can be monitored during the test by using the functions of the Engineering Menu. See Appendix A2.

The Performance test consists of two main parts, the Static Test and the Dynamic Test.
For the Static Test, the humidifier is first run with fixed inputs to check for correct heater plate control. Initially the heater plate will get warm, but should be relatively cold at the end of the first part of this test.
The second part of the Static Test checks the over temperature protection. At the end of this test the heater plate will be at maximum temperature.

For the Dynamic Test, the humidifier with a chamber is fitted with a Heater Wire delivery tube assembly and a probe assembly. The delivery tube should be supported from above so that it drops vertically over its entire length to the top of the chamber.

While testing the Heated Wire models, the chamber does not require to be filled with water or have a gas supply but the chamber inlet must be unobstructed. The purpose of this set-up is to establish an air flow through the chamber and up the delivery tube by convection.

The MR730/720 is to be tested in the Heater Wire on mode (green LED on). The non Heated Wire model MR480 is tested slightly differently. See section 6.4.

6.2 PERFORMANCE CHECK MR730/720/700

Ensure the MR730/720/700 model has a suitable Heater Wire module connected.
See section 6.4 for testing of MR480.
NOTE: Please ensure that the procedures are followed correctly to avoid misleading test results.

6.2.1 EQUIPMENT REQUIRED

1) 34.5 °C Test probe, available in MR700 series calibration kit (F & P part no. 900MR548).
2) Delivery hose and heater wire assembly (1.1 to 1.3 metre Adult).
3) Dual probe assembly.
4) A humidification chamber without scroll. **(Not an MR390.)**

6.2.2 STATIC TEST SEQUENCE (MR730/720/700)

Connect the Heater Wire cable to the humidifier. Do not at this stage connect the probe assembly to the humidifier or the delivery tube to the humidification chamber outlet.

1) Plug in a 34.5 degree test probe.

2) Turn the Temperature Control knob to 33.0 ± 0.2 degree and Chamber Control to 0.

3) Turn on the humidifier mains power switch.

4) Check the Temperature Control and Chamber Control setting by noting display readings during initialisation.

5) Check display reading of 34.5 ± 0.2 after initialisation and that the Set Low warning light is on.

6) Push Chamber temp. button and check for 34.5 ± 0.2 degree reading.

7) Run for 30 minutes without interruption. If mains power is interrupted test will have to be restarted.

8) After 30 minutes Check:
Heater plate cold. Less than 60 °C (hP engineering menu).
Heater Wire cold (feel).

9) Turn the humidifier main power switch off.

10) Turn the temperature control knob to 36.0 ± 0.2 °C and leave Chamber Control set at 0.

11) Turn on the mains power.

12) Check temperature control knob setting during initialisation.

13) Run for 30 minutes without interruption.

14) After 30 minutes Check:
Heater plate hot (Greater than 80 °C).
Heater Wire hot (feel).

15) Turn off the humidifier.

6.2.3 DYNAMIC TEST SEQUENCE (MR730/720/700)

1) Remove the 34.5 °C Test probe and connect the vertically supported delivery tube to the outlet of the empty chamber (any no scroll chamber other than an MR390) on the humidifier.

2) Connect the Heater Wire cable and probe assembly to the humidifier.

3) Turn Set control to 36.0± 0.1°C and Chamber Control to 0.

4) Turn on mains power and check settings during initialisation.
Note: At low ambient temperatures (below 22 °C) the Heater Wire under the low flow conditions of the test will warm up only slowly and may give a low temperature alarm. If this is muted the breathing circuit will eventually warm and the humidifier will start controlling.

5) Check after 10 minutes that digital display is 36.0 ± 0.3°C

6) After ½ hour check chamber outlet temperature is 36.0 ± 2.0°C

7) Continue to run for 3 hours, then check the following:
Airway temperature 36.0 ± 0.3°C
In 'Engineering Mode' (see appendix A2):
set = 36 ± 0.1°C
offset = 0
Edc => 0
Cdc => 0
hp = > 36°C
and there are no spurious alarms.

8) Rotate temperature control knob to 38 and check for an Airway Temperature Low alarm. (For MR720 set to 40 degrees).

9) Rotate temperature control knob to 34 and check for an Airway Temperature High alarm.

10) Rotate the chamber control to -2.5 and check that the set low light comes on.

11) Check Heater Wire wire plug disconnect gives audio alarm and Heater Wire alarm light.

12) Push the Heater Wire switch and check that Heater Wire off gives Audio alarm and Heater Wire alarm light.

13) Disconnect the temperature probe and check the Temperature Probe LED flashes and gives an audio alarm.

14) Push the Mute button and check alarm silencing.

15) Unit is now ready for service.

6.3 PERFORMANCE CHECK (MR480)

The test consists of two main parts: the Static Test and the Dynamic Test.

For the Static Test the humidifier is first run with fixed inputs to check for correct heater plate control. Initially the heater plate will get very hot but should be cool at the end of the first part of this test. The second part of the Static Test checks the over temperature protection. At the end of this test the heater plate will be at maximum temperature.

For the Dynamic Test, the humidifier with a full chamber (use only MR310 chambers) is fitted with a delivery tube assembly and a probe assembly. The delivery tube should be supported vertically.
NOTE: Please ensure that the procedures are followed correctly to avoid misleading results.

6.3.1 EQUIPMENT REQUIRED

1) 34.5 °C Test probe.
2) A non heated delivery circuit (1.1 to 1.3 metre Adult).
3) Dual temperature probe assembly such as 900MR560.
4) An MR310 humidification chamber or similar scrolled reusable chamber.

6.3.2 STATIC TEST PROCEDURE (MR480)

1) Plug in the 34.5 degree test probe.

2) Turn the temperature control knob to 33.0 ± 0.2 degree.

3) Turn on the humidifier main power switch.

4) Check that 33.0 ± 0.2 flashes on the display during initialisation.

5) Check display reading of 34.5 after initialisation (± 0.2).

6) Push Chamber Temp. button and check for 34.5 degree reading (± 0.2).

7) Run for 1 hour without interruption. If mains power is interrupted test will have to be restarted.

8) After 1 hour check the engineering menu (Appendix A2):
   Set = 33
   hp = <70

9) Turn off the humidifier

10) Turn the temperature control knob to 36.0 ± 0.2 degree (check correct setting is displayed when the control is adjusted).

11) Check temperature control knob setting during initialisation.

12) Run for 1 hour without interruption.

13) After 1 hour check the engineering menu (appendix A3):
Set = 36
hp = > 80

14) Turn off the humidifier.

6.3.3 DYNAMIC TEST PROCEDURE (MR480)

Remove the 34.5 °C Test probe and connect the vertically supported delivery tube to the outlet of a full MR310 or similar humidification chamber on the humidifier. Connect the probe assembly to the humidifier. The chamber inlet should be unobstructed.

Note: The MR480 design specifications preclude it from controlling perfectly under these conditions of extremely low gas flow, caused only by convection. The fact that it does control, be it not perfectly, is an excellent simple test of its over-all control capability.

1) Turn on the humidifier.
At low ambient temperatures (below 22 °C) the airway circuit under the low flow conditions of the test will warm up only slowly and may give a low temperature alarm. If this is muted the circuit will eventually warm up and start controlling.

2) Turn Temperature Set control to 31.0 ± 0.1, check that correct setting flashes on display after adjustment

3) Check after one hour that digital display is 31.0 ± 1.0.

4) After 1 hour press chamber temp button and check:
chamber temperature is 35 - 66 °C.
In Engineering menu (appendix A2) check:
hp (heater plate temperature) = 60 to 100°C
Set = 31.0 ± 0.1.°C

5) Continue to run for 3 hours, periodically checking the display is 31.0 ± 1.0 and that there are no spurious alarms.

6) After three hours check in Engineering menu:
set = 31± 0.1°C
dc = > 0
hp = > 36°C

7) Check that disconnecting the temperature probe gives an audio alarm and Temp Probe LED flashes.

8) Press Mute button and check the alarm is silenced.

9) Humidifier is now ready for use.

6.4 DUAL PROBE TEMPERATURE TEST

This test is required to be performed on all temperature probes every three months or if there is any doubt as to the accuracy of the temperature probe. This test allows the operator to compare the temperature readings of both probes (chamber and airway) firstly to one another, and secondly to a glass thermometer for absolute verification of temperature if so desired. In the first case assuming that both probes have not failed in a similar manner, any probes exhibiting a temperature difference of greater than 1.5 °C would be suspect. In the second case depending on the accuracy of the mercury in the glass thermometer any probes not agreeing within ± 1.5 °C of the thermometer reading would also be suspect.

6.4.1 EQUIPMENT REQUIRED

1) Dual Temperature probe to be tested.
2) Mercury filled glass thermometer.
3) Cup of warm water (Ambient to 40°C).
4) Heater wire if using humidifier in heater wire mode.

6.4.2 TEST PROCEDURE

1) Plug the dual probe into the Humidifier, if in Heater Wire mode ensure a heater wire assembly is connected.

2) Turn on the mains power.

3) Insert both temperature probes into a container filled with water at a temperature between ambient and 40 °C. As temperature gradients can be quite large it is recommended that the two probes be held together with a rubber band during this test and the water constantly stirred.

4) Place the thermometer in the water alongside the probes and allow two minutes for the temperatures to stabilise. It is recommended that the water be constantly stirred during this test.

5) Enter the Engineering menu (refer Appendix A2) and select 'CP' (compare probes) option. The display will alternate between the airway and chamber temperatures (chamber temperature is displayed with all decimal points turned on).

6) Check the temperature difference between chamber and airway probes as indicated by the display, it should not exceed 1.5 °C.

7) Ensure that the chamber and airway probes are within 1.5°C of the mercury thermometer reading.

7.0 SERVICING INFORMATION

7.1 INTRODUCTION

This section provides information for servicing the MR730/720/700/480 Humidifier. The electronic circuitry is contained on two separate circuit boards, the power board and control board.
Please note the following:

- Follow ESD precautions when handling circuit boards.
- After replacing or modifying a circuit board, go through the calibration and performance tests outlined in sections 5 and 6.
- After any repair involving opening of the humidifier, go through the electrical safety tests outlined in Appendix B2.
- When replacing any screws, refer to torque settings in section 7.6

7.2 PRINTED CIRCUIT BOARD REMOVAL

7.2.1 CONTROL PCB

The front panel and heater plate assembly is separated from the humidifier body by removing the 4 fixing screws from the rear of the humidifier body. The front panel assembly can now be moved aside and the two ribbon cable connectors (J1 and J2) disconnected from the rear of the control board. If the front panel is now positioned face down the three plastic retaining latches protruding through the board can be moved in the appropriate direction to release the board. This is facilitated if a slight upward finger pressure is maintained on either edge of the board, when the latches release, the board will pop up leaving the push on control knobs behind in the front panel.

7.2.2 POWER PCB

Separate the case front from the humidifier body and disconnect the two ribbon cable connectors joining the Power PCB and Control PCB (J1 and J2). Cut the cable tie holding the heater plate and chassis wires together.

The power board and heat sink assembly can now be removed by flexing the case sides away from the top edge of the board and moving the board forward slightly to disengage from the case. The board should now be lifted slightly to clear the lower retaining guides and moved further forward to gain access to the various wiring harness connectors which can now be detached. Before removing the PCB, unscrew the mains cord connections and cut the cable tie holding the mains cord in place.

7.3 REPLACEMENT OF REVISION D POWER & CONTROL PCB ASSEMBLIES

For any repair work which requires replacement of a revision D control or power board on the 700 Series humidifiers both PCB's need to be upgraded together. This affects all Humidifiers with serial numbers up to 92XXAAA05495 excluding French/German models, and up to 93XXAAA01818 on French/German models. To upgrade both PCB's and the software use a PCB service upgrade kit, the part numbers to order are as follows:

MR480 043040791
MR700 043040792
MR720 043040793
MR730 043040794

The kit will include:
Installation Instructions
Latest Revision Control Board
Latest Revision Power Board
Latest Version Software installed
Latest Version Operating Manual

For humidifiers with serial numbers after those mentioned above (Rev F or later PCB's), you will only

be required to purchase individual boards for repairs (as detailed in Section 8.9 Electrical Parts List). On completion of a repair using the upgrade kit, future repairs need only individual boards to be replaced.

7.4 HEATER PLATE

To reset the 118 °C over temperature cutout, separate the case front from the case body, then push the reset button (through a small hole under the heater plate in the front panel case assembly).

To replace the heater plate:

1) Separate the case front from the humidifier body.
2) Unclip the Power PCB from the case body (see 7.2.2(b) above).
3) Unplug the heater plate wires from the Power PCB (connectors J3 and J7).
4) Unscrew the earth screw on the chassis for the heater plate earth wire.
5) Unplug the ribbon cables from the Power PCB to the Control PCB (connectors J1 and J2). The front case assembly is now separate from the case body.
6) Detach the heater plate from the case front by removing the three screws which secure it to the case front.

When replacing the heater plate, ensure that the three springs are in place on the heater plate fixing legs *(check the heater plate spring loading).*
Assembly is the reverse of the above procedure.

7.5 FAULT LOCATION

If neither the digital display nor any of the front panel LED's are on and no power appears to be reaching the transformer primary, check that the mechanical overheat protector on the heater plate has not cut out. This may be checked by depressing the red reset button. (See 7.4 above.)

Determine if all power supplies are operational and all fuses are intact. If the power supplies are OK but the display is blank, check the watch dog output (pin 12, U5g). A high output here will blank the display, turn on the humidifier fault LED indicator and isolate the heater circuits but not necessarily stop the processor. Check for the presence of a 33 - 40ms period square wave at PB7 (pin 1 U5b). If the watch dog output is high and the 33 - 40ms clock is present a fault in the watch dog circuitry is indicated but if port PB7 is not changing state there is a fault elsewhere.

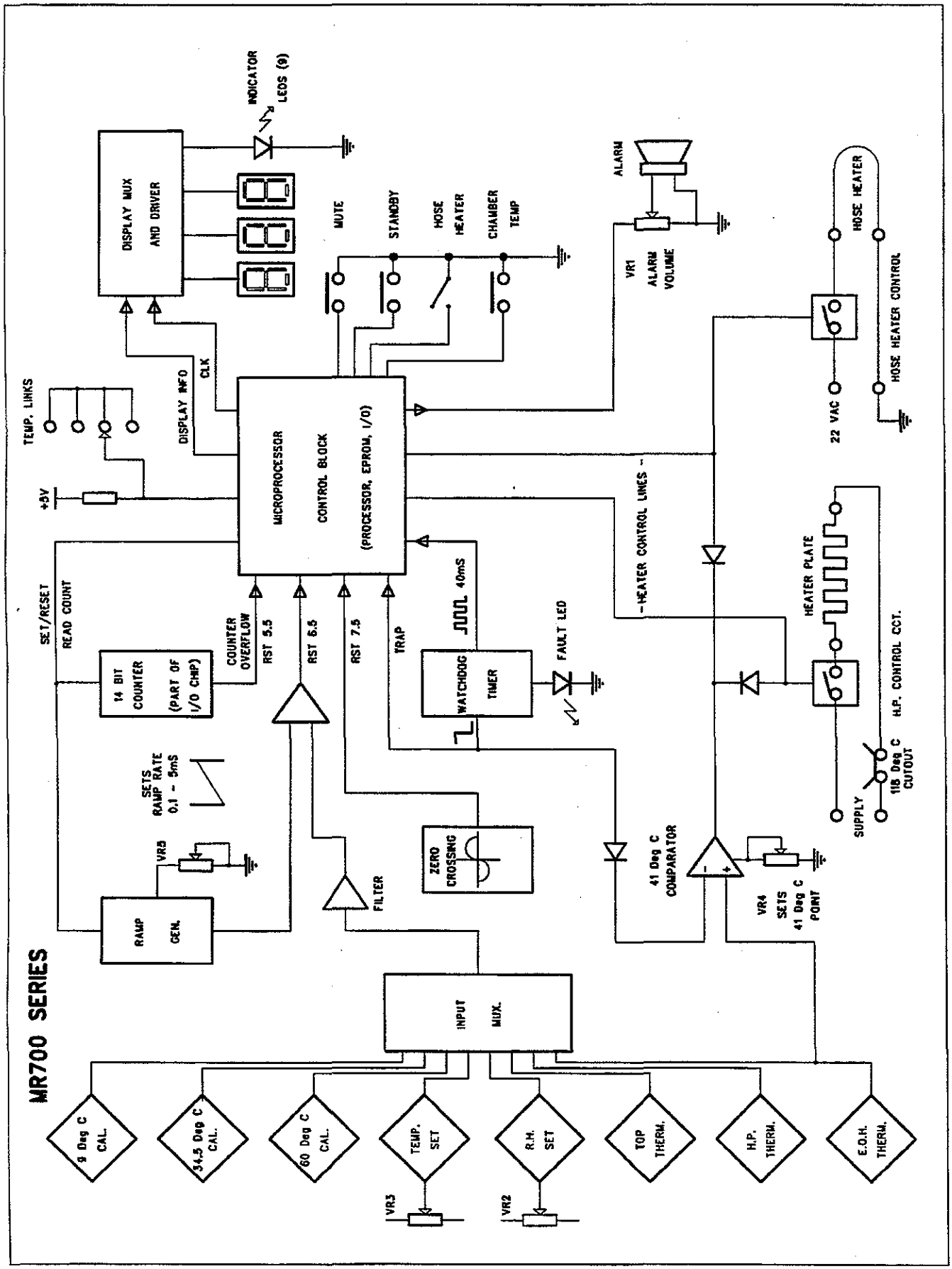
7.6 SCREW TORQUE SETTINGS

Use a torque driver with the correct bit attached and tighten screws to the torques specified below.

Ref	Screw	Application	Driver	Torque Range (Nm)
CHASSIS				
14	Screw #8 x ½" Pan Phil TY25 S/S	Case Front/Body	Phillips	0.6 - 0.8
18	Screw M4 x 8 Pan Phil Taptite	Chassis Earth Screws	Phillips	1.7 - 1.9
21	Screw M6 x 25 Csk Allen S/S	Mounting Bracket	Allen	1.75 - 1.95
22	Screw M4 x 14 Pan Pozi Taptite	Mains Cord Clamp	Pozidrive	1.4 - 1.7
26	Screw M6 x 16 Allen S/S Button Head	Chassis Earth Screw	Allen	1.75 - 1.95
27	Screw M3 x 5 Pan Phil Taptite	Heater plate Standoffs	Phillips	0.7 - 0.8
HEATER PLATE				
2	Screw M4 x 8 Pan Phil Taptite	Heater plate Earth/Element	Phillips	1.5 - 1.8
5	Screw M3 x 5 Pan Phil Taptite	Thermistor/Thermostat Heater plate	Phillips	0.7- 0.8

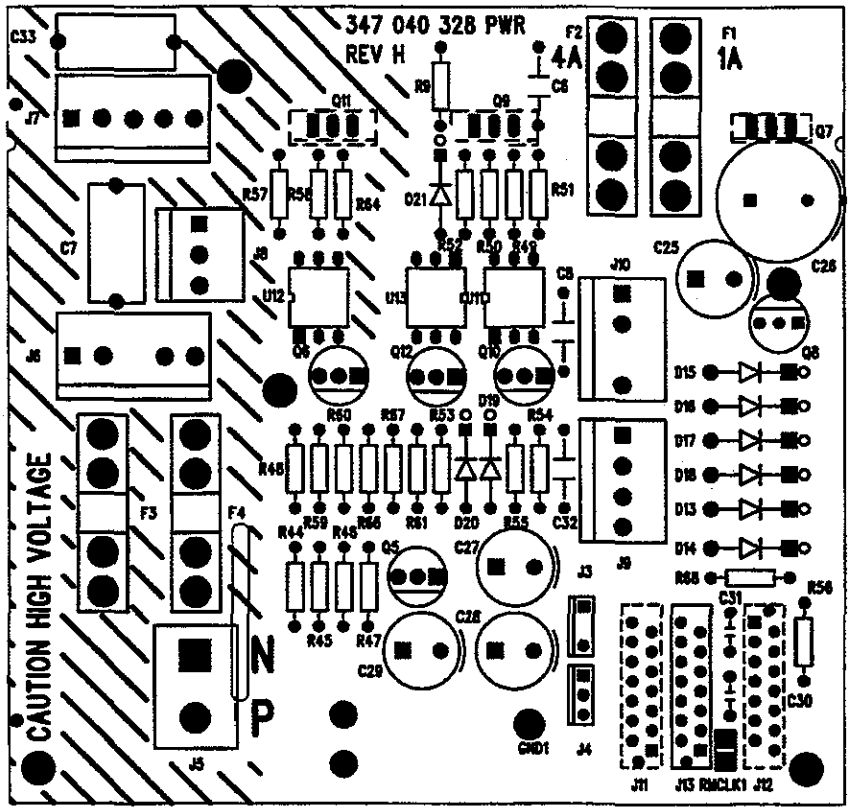
8.0 Schematics, Part Lists and Mechanical Drawings

8.1 MR700 Series Circuit Layout Block Diagram

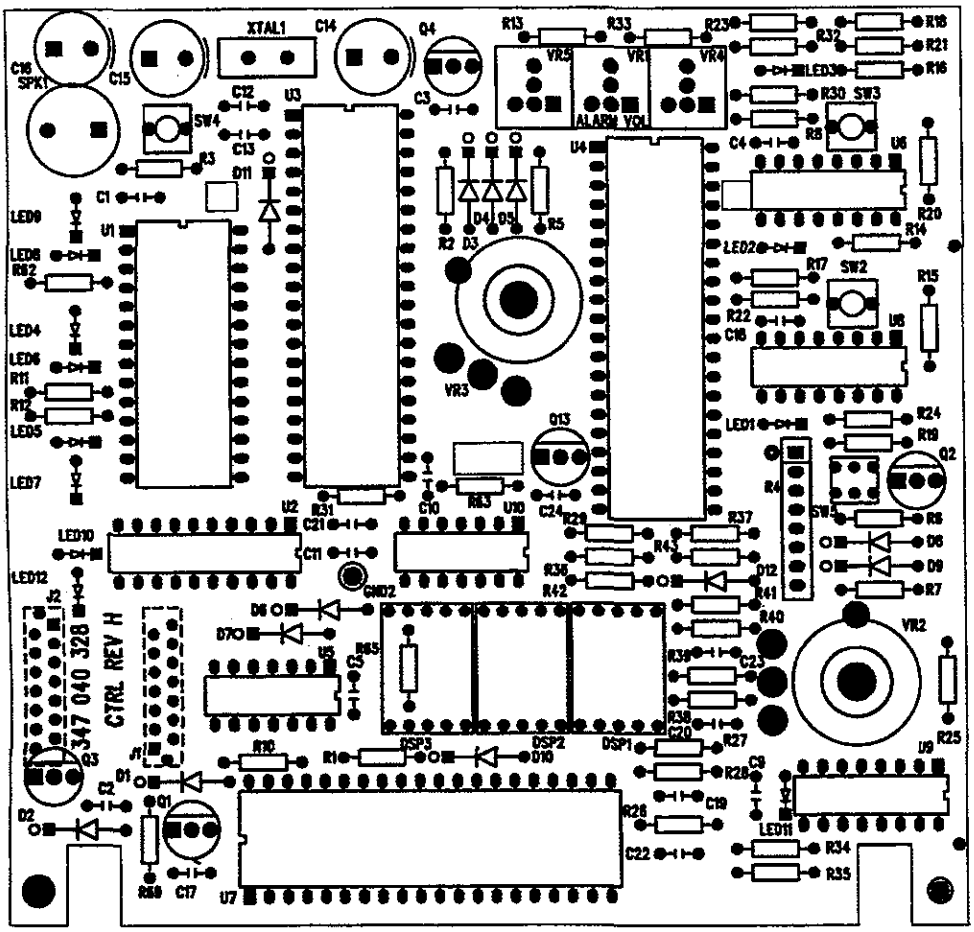


8.2 Component Layout - Revision H PCB

Power Board:

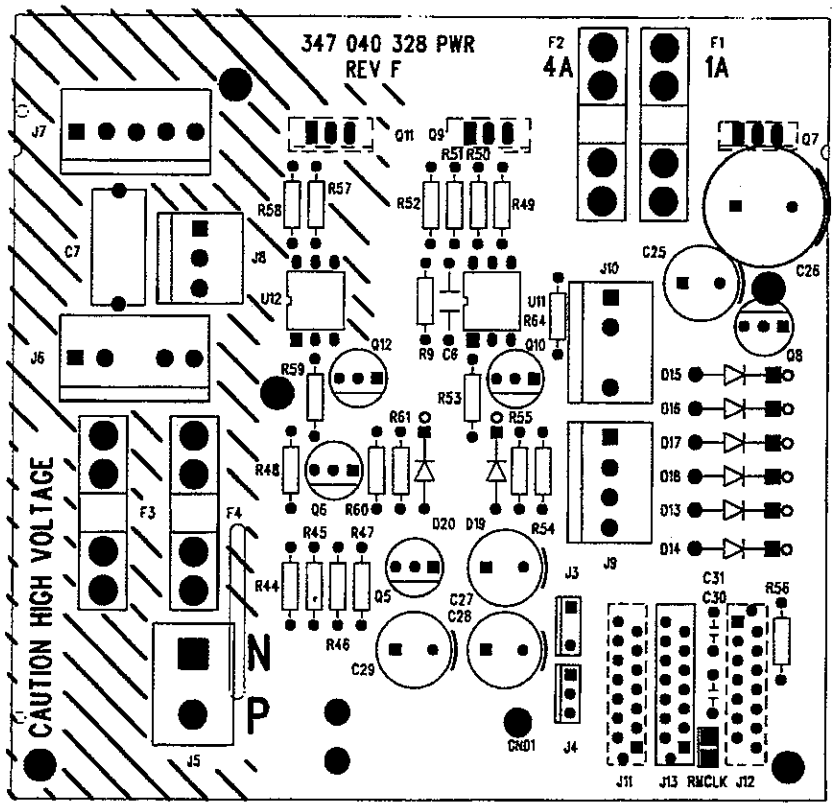


Control Board:

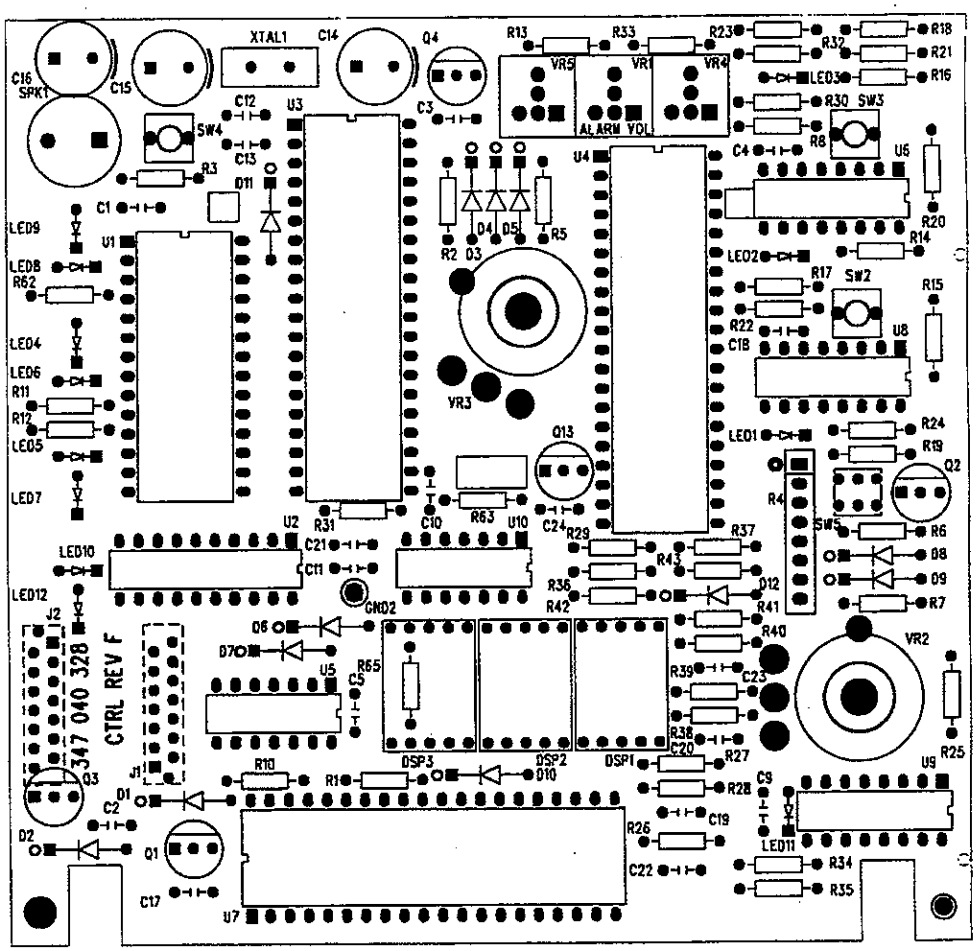


8.3 Component Layout - Revision F PCB

Power Board:

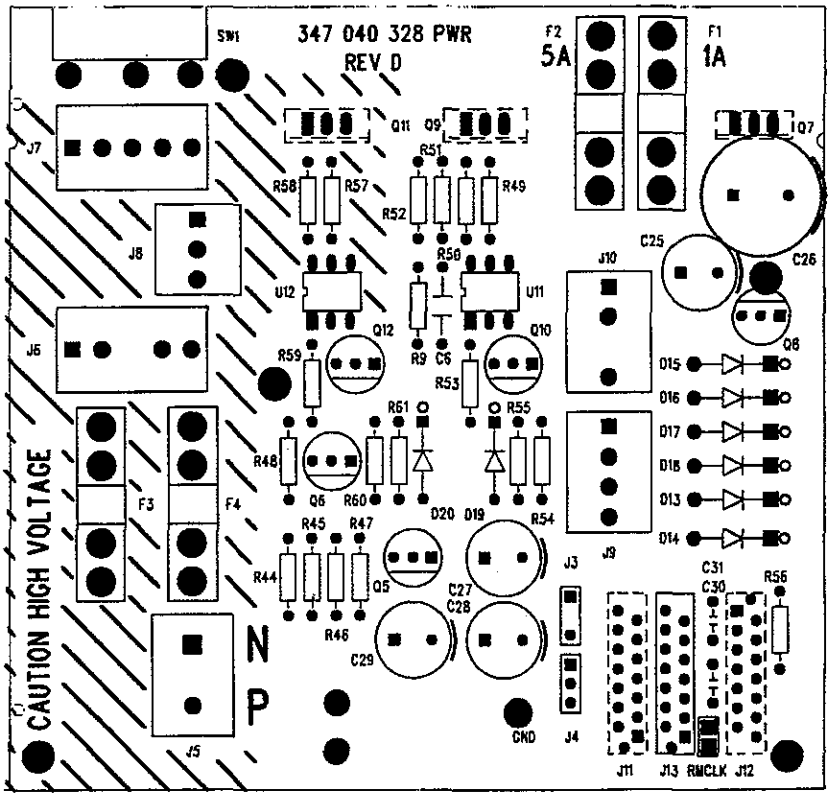


Control Board:

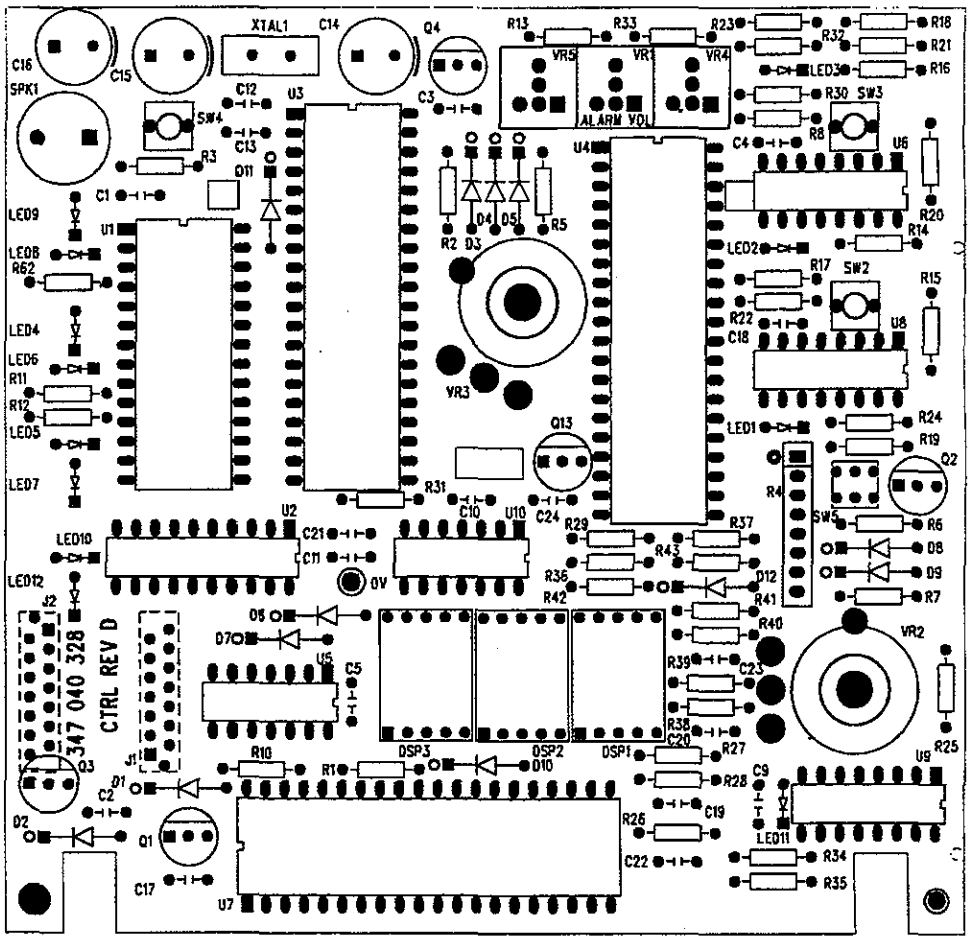


8.4 Component Layout - Revision D PCB

Power Board:

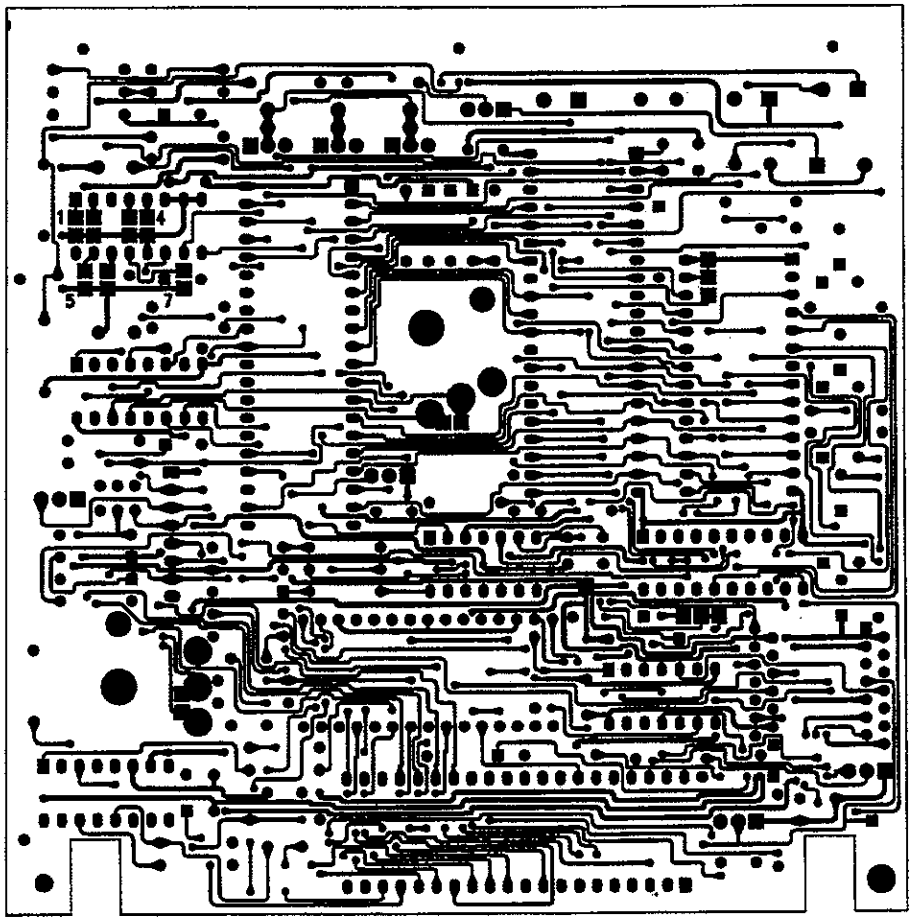


Control Board:



8.5 Link Pad Locations For Programming Control Options - Revision H PCB

Link Pads →

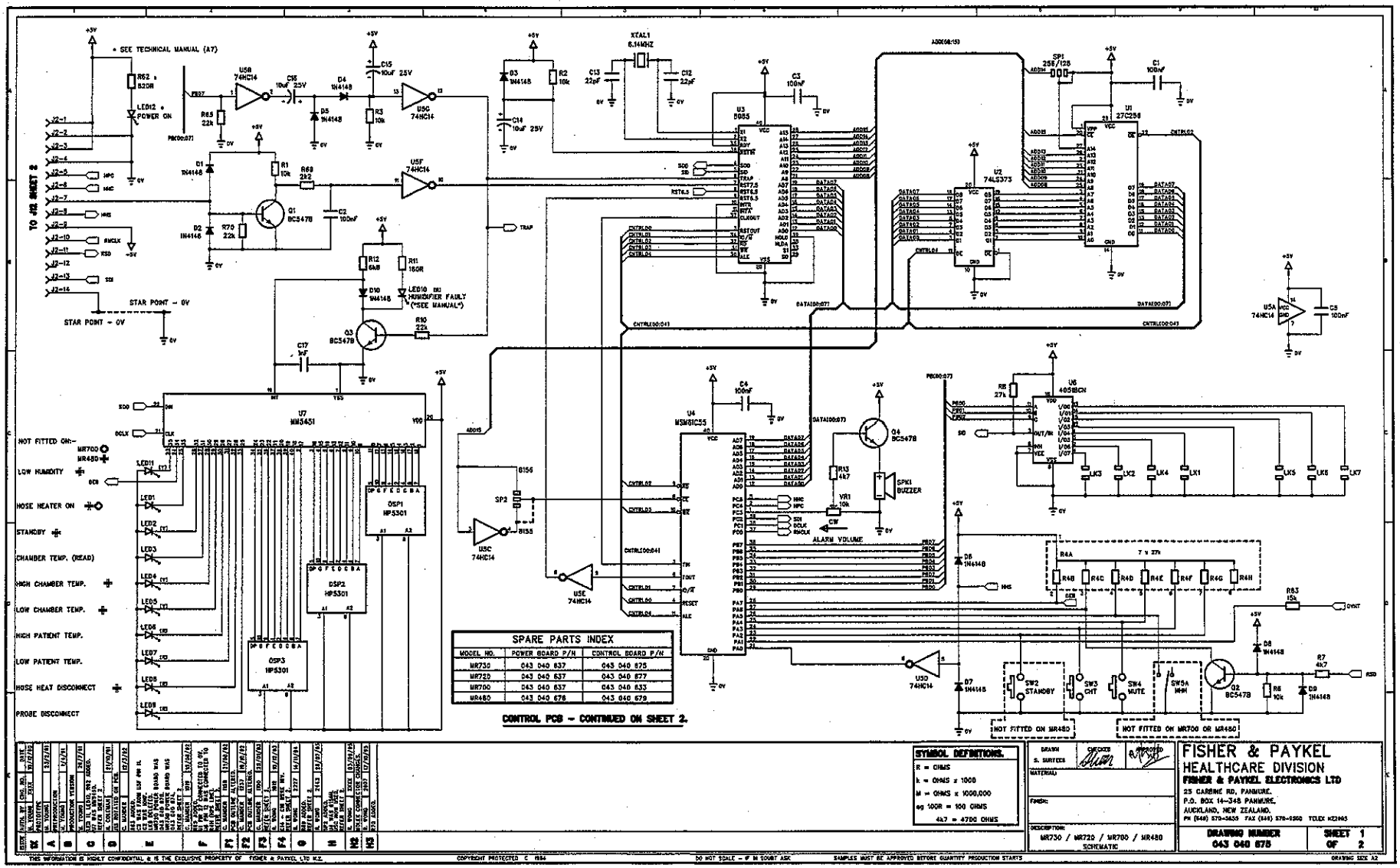


Control Board:
viewed from
solder side

Location of Link Pads for Programming Control Options (see Appendix A3)

CIRCUIT DIAGRAMS - REVISION H PCB

CONTROL PCB



SPARE PARTS INDEX		
MODEL NO.	POWER BOARD P/N	CONTROL BOARD P/N
MR730	043 040 637	043 040 675
MR720	043 040 637	043 040 677
MR700	043 040 637	043 040 633
MR480	043 040 676	043 040 679

CONTROL PCB - CONTINUED ON SHEET 2.

SYMBOL DEFINITIONS.

R = OHMS
k = OHMS x 1000
M = OHMS x 1000,000
eg 100R = 100 OHMS
4k7 = 4700 OHMS

DRAWN S. SURTEES
CHECKED
APPROVED
MATERIAL
FINISH
DESCRIPTION: MR730 / MR720 / MR700 / MR480 SCHEMATIC

FISHER & PAYKEL
HEALTHCARE DIVISION
FISHER & PAYKEL ELECTRONICS LTD
25 CARBINE RD, PANMURE,
P.O. BOX 14-348 PANMURE,
AUCKLAND, NEW ZEALAND.
PH (649) 570-5633 FAX (649) 570-6300 TELEX NZ2965

DRAWING NUMBER 043 040 675
SHEET 1 OF 2
DRAWING SIZE A2

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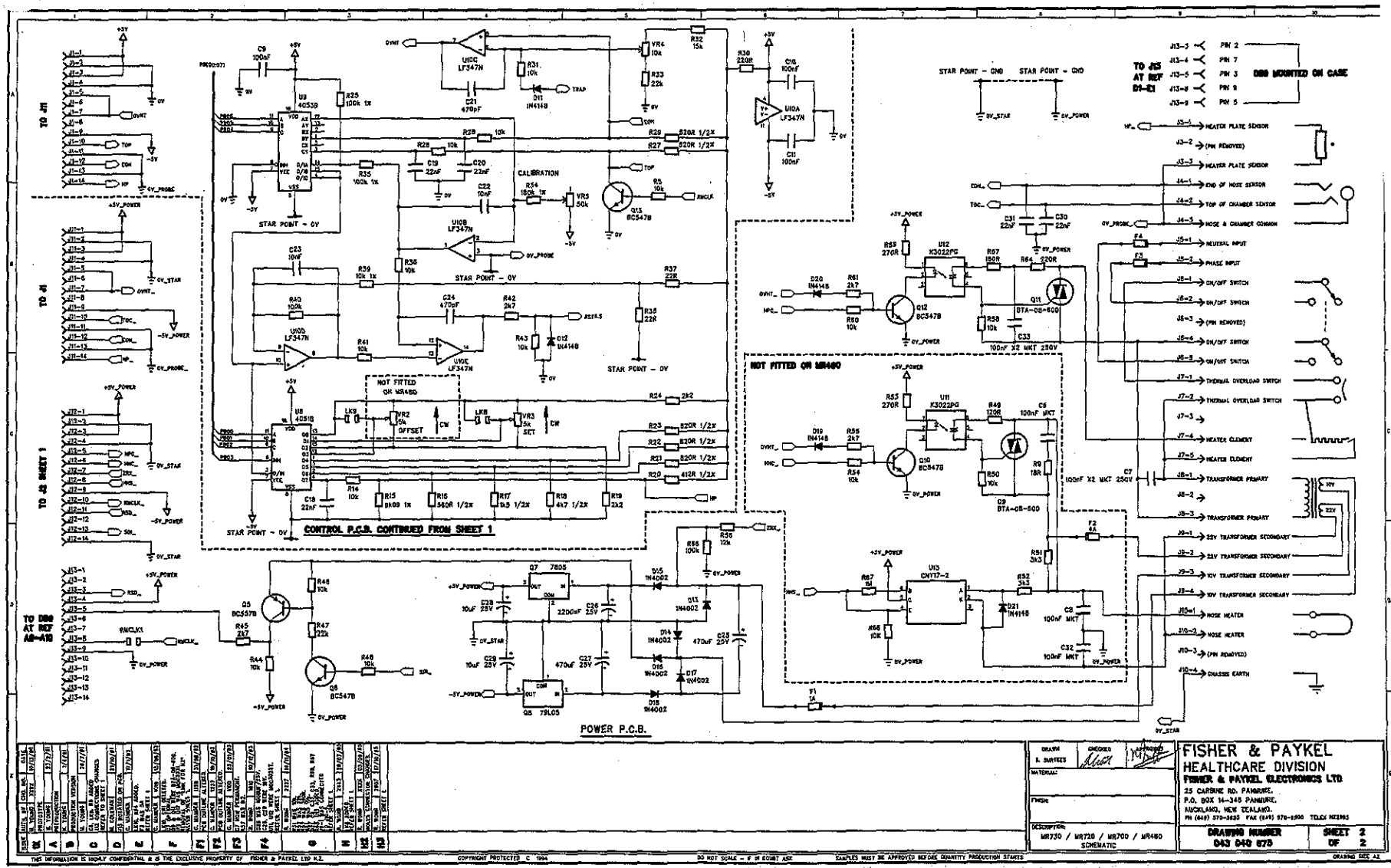
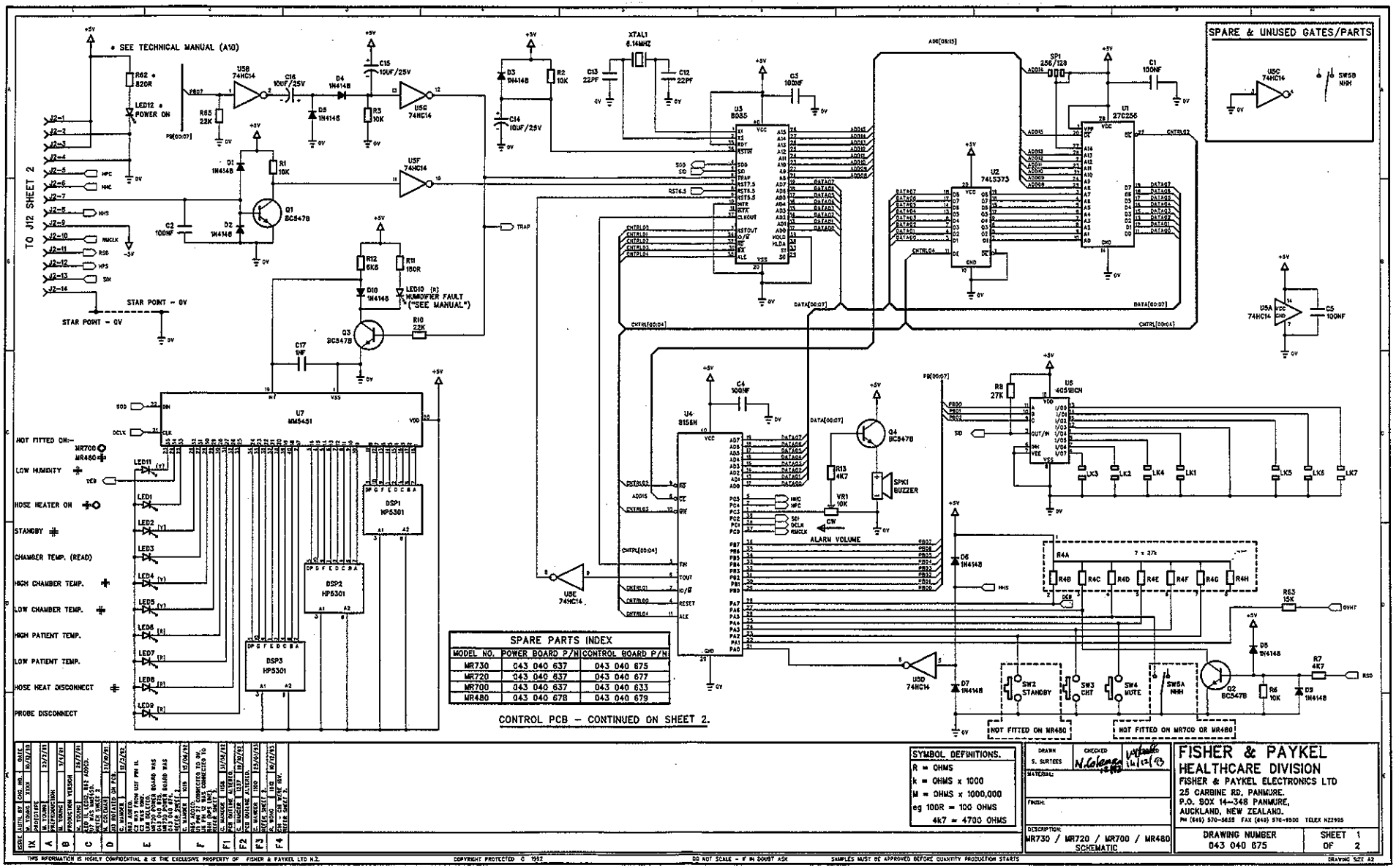
COPYRIGHT PROTECTED © 1994
DO NOT SCALE - IF IN DOUBT ASK
SAMPLES MUST BE APPROVED BEFORE QUANTITY PRODUCTION STARTS

8.6 RCUIT DIAGRAMS - REVISION H PCB. POWER PCB




SPARE & UNUSED GATES/PARTS
* SEE TECHNICAL MANUAL (A10)
TO J12 SHEET 2
STAR POINT = 0V
NOT FITTED ON:-
MR700
MR480
LOW HUMIDITY
HOSE HEATER ON
STANDBY
CHAMBER TEMP. (READ)
HIGH CHAMBER TEMP.
LOW CHAMBER TEMP.
HIGH PATIENT TEMP.
LOW PATIENT TEMP.
HOSE HEAT DISCONNECT
PROBE DISCONNECT
HUMIDIFIER FAULT ("SEE MANUAL")
ALARM VOLUME
BUZZER
NOT FITTED ON MR480
NOT FITTED ON MR700 OR MR480
CONTROL PCB - CONTINUED ON SHEET 2.
SPARE PARTS INDEX
MODEL NO. | POWER BOARD P/N | CONTROL BOARD P/N
MR730 | 043 040 637 | 043 040 675
MR720 | 043 040 637 | 043 040 677
MR700 | 043 040 637 | 043 040 633
MR480 | 043 040 678 | 043 040 679
SYMBOL DEFINITIONS.
R = OHMS
k = OHMS x 1000
M = OHMS x 1,000,000
eg 100R = 100 OHMS
4k7 = 4700 OHMS
DRAWN S. SURTEES
CHECKED N.Colenso
DESCRIPTION: MR730 / MR720 / MR700 / MR480 SCHEMATIC
FISHER & PAYKEL
HEALTHCARE DIVISION
FISHER & PAYKEL ELECTRONICS LTD
25 CARBINE RD, PANMURE.
P.O. BOX 14-348 PANMURE,
AUCKLAND, NEW ZEALAND.
DRAWING NUMBER 043 040 675
SHEET 1 OF 2
DRAWING SIZE A2

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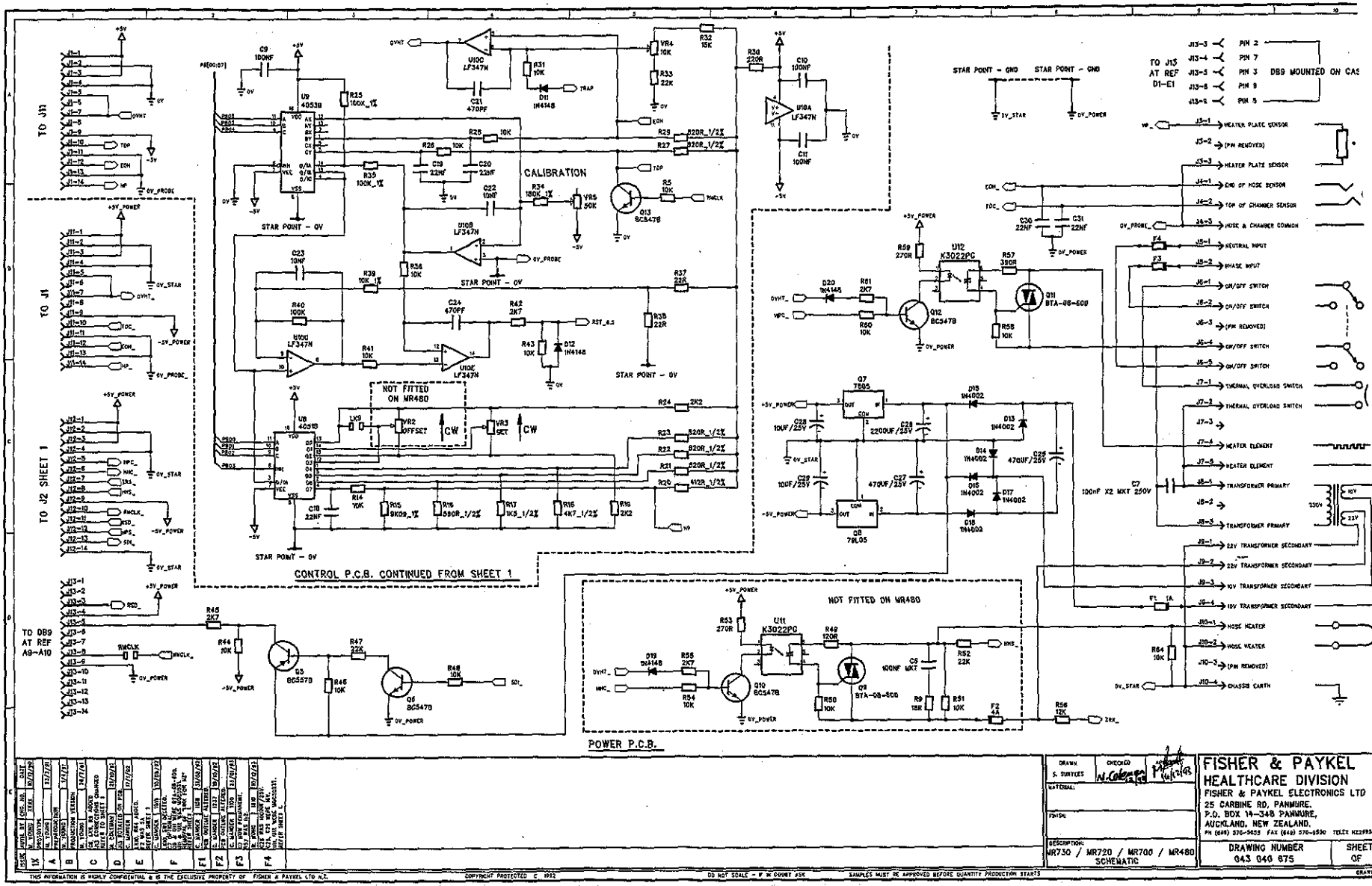
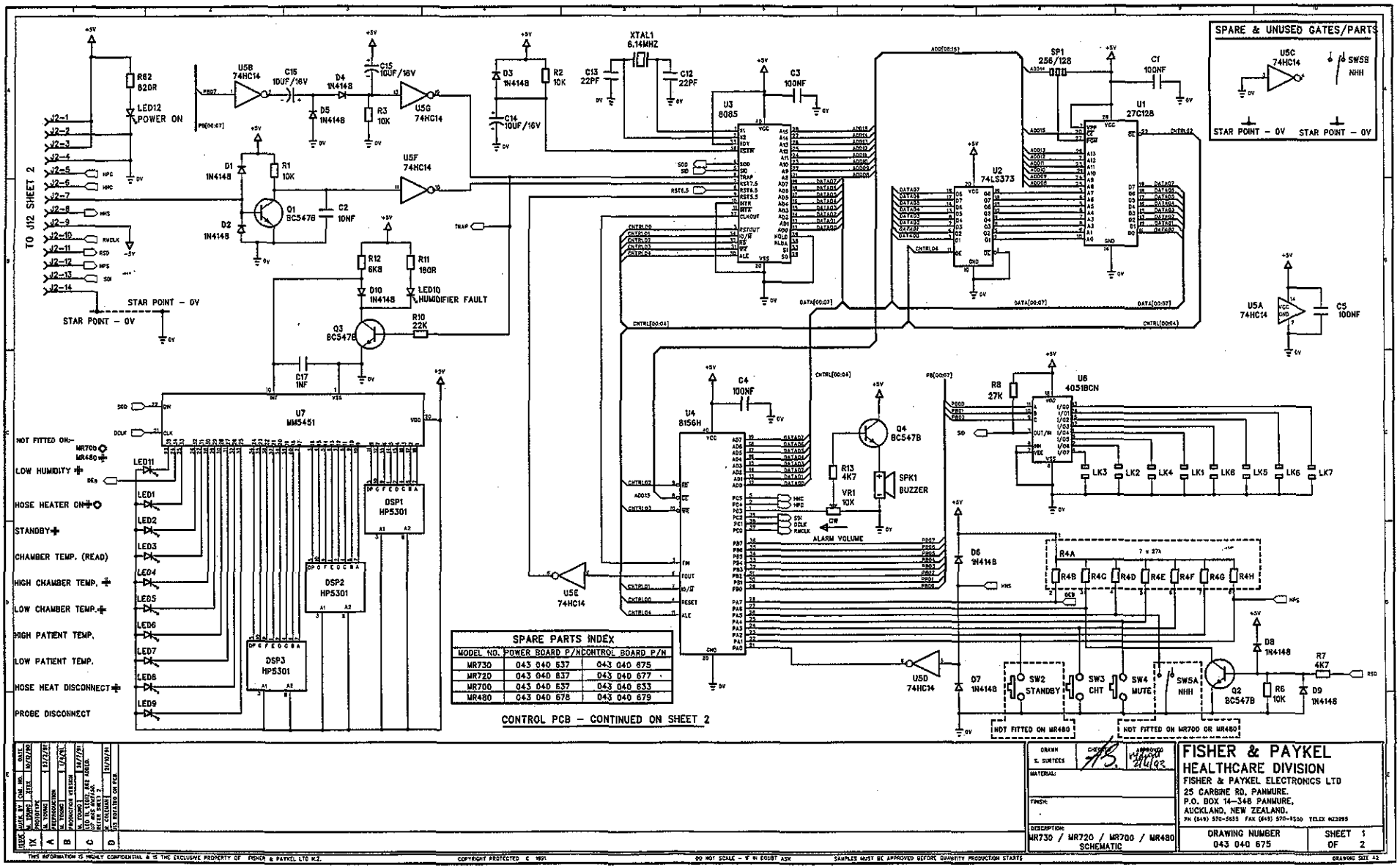
8.7 CIRCUIT DIAGRAMS - REVISION F PCB POWER PCB



CIRCUIT DIAGRAMS - REVISION D PCB

CONTROL PCB



SPARE PARTS INDEX		
MODEL NO.	POWER BOARD P/N	CONTROL BOARD P/N
MR730	043 040 637	043 040 675
MR720	043 040 637	043 040 677
MR700	043 040 637	043 040 633
MR480	043 040 678	043 040 679

CONTROL PCB – CONTINUED ON SHEET 2

ISSUE	DATE	CHG. NO.	DETAILS	ISSUED BY
IX	16/8/90	M. 2596	PROTOTYPE	
A	3/12/91	M. 2596	PREPRODUCTION	
B	1/4/92	M. 2596	PRODUCTION VERSION	
C	14/7/92	M. 2596	USE ADJ. MOT/AC. SEE PANEL. REFER SHEET 2.	
D	21/10/93	M. 2596	AS PLOTTED ON PCB	

DRAWN: S. SUTTEES
CHECKED
APPROVED: 21/4/92
MATERIAL:
FINISH:
DESCRIPTION: MR730 / MR720 / MR700 / MR480 SCHEMATIC

FISHER & PAYKEL
HEALTHCARE DIVISION
FISHER & PAYKEL ELECTRONICS LTD
25 CARBINE RD, PANMURE,
P.O. BOX 14-348 PANMURE,
AUCKLAND, NEW ZEALAND.
PH (649) 570-5633 FAX (649) 570-5500 TELEX NZ2395

DRAWING NUMBER 043 040 675
SHEET 1 OF 2
DRAWING SIZE A2

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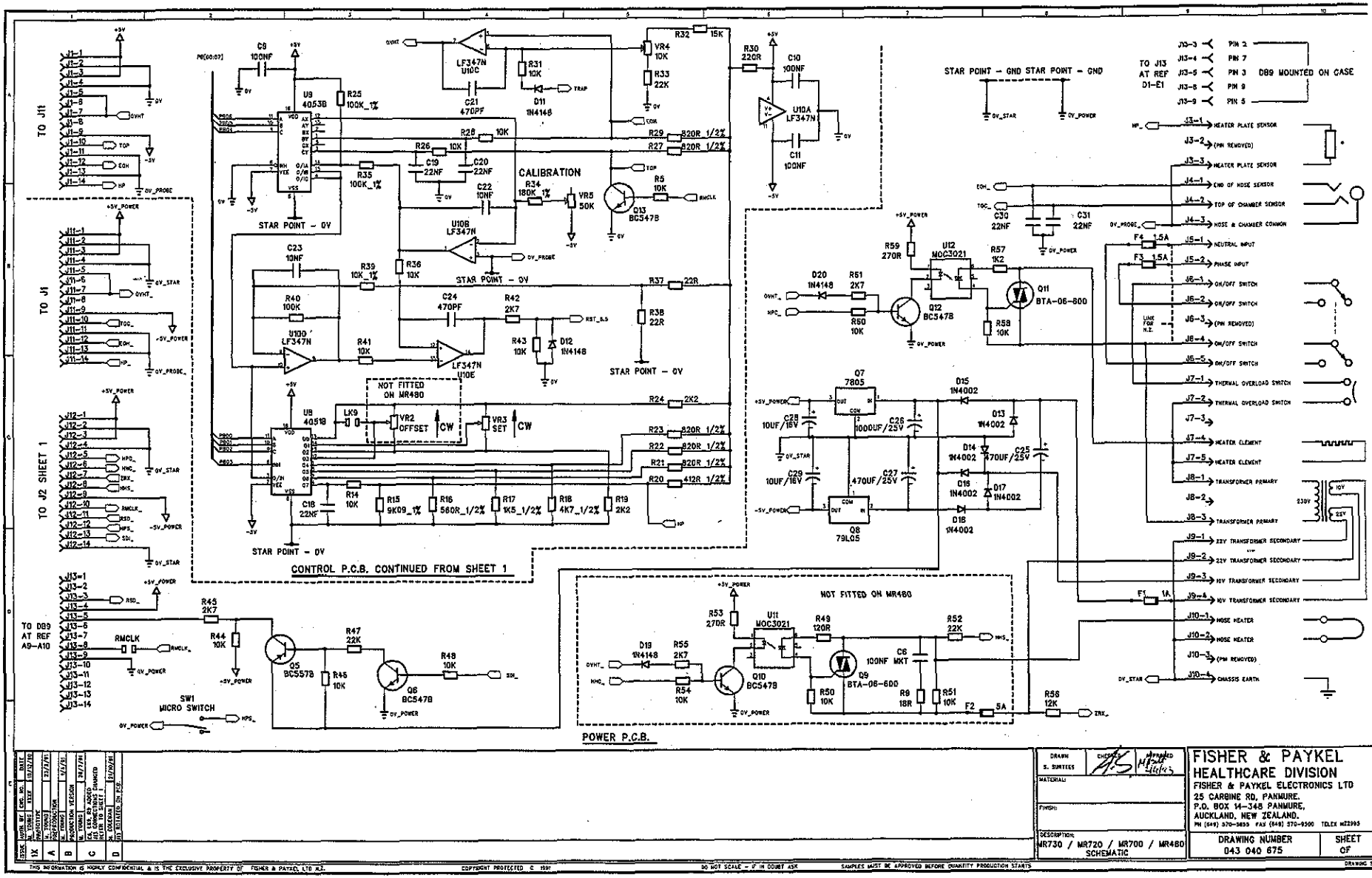
8.8 CIRCUIT DIAGRAMS - REVISION D PCB — POWER PCB



8.9 ELECTRICAL PARTS LIST

The electrical components listed below are referenced in accordance with the component layout (Section 8.2) and the circuit diagrams (Section 8.6).

Note: The Control and Power PCB Assemblies listed below are replacement parts for Revision F & H PCB's. For replacement of Revision D PCB's refer to Section 7.3 for details of upgrade kits.

8.9.1 CONTROL BOARD COMPONENTS: (REVISION H PCB)

Ref.	Description	Part No.
	Control PCB Assembly MR480 (No Eprom)	043040679
	Control PCB Assembly MR700 (No Eprom)	043040633
	Control PCB Assembly MR720 (No Eprom)	043040677
	Control PCB Assembly MR730 (No Eprom)	043040675
	Eprom Programmed MR480 Ver 3.0	362040076
	Eprom Programmed MR700 Ver 3.0	362040077
	Eprom Programmed MR720 Ver 3.0	362040078
	Eprom Programmed MR730 Ver 3.0	362040079
C1, C3, C4, C5, C9, C10, C11	Cap. Ceramic 100nF 50V	312040153
C2	Cap. Mylar 100nF 50V	316040085
C12, C13	Cap. Ceramic 22pF 50V	312040130
C14, C15, C16	Cap. Elec. 10µF 25V	311040663
C17	Cap. Ceramic 1nF 50V	312040107
C18, C19, C20	Cap. Ceramic 22nF 50V	312040116
C22, C23	Cap. Mylar 10nF 50V	316040084
C21, C24	Cap. Ceramic 470pF 50V	312040118
D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12	Diode 1N4148	361040155
DSP1, DSP2, DSP3	Display LED (HDSP5301 or LA6760)	999860001
J1A, J2A	14 pin ribbon connector socket	341040357
LED1, LED3	LED green	361040329
LED2, LED4, LED5, LED11	LED amber/yellow	361040328
LED6, LED7, LED8, LED9, LED10	LED red	361040327
Q1, Q2, Q3, Q4, Q13	Transistor BC547B	361040159
R1, R2, R3, R5, R6, R14, R26, R28, R31, R36, R39, R41, R43	Resistor 10k 0.25W 5%	325040284
R4	Resistor DIL Resistor pack 7/27k 5%	325046010
R7, R13	Resistor 4k7 0.25W 5%	325040287
R8	Resistor 27k 0.25W 5%	325040319
R10, R33, R65, R70	Resistor 22K 0.25W 5%	325040318
R11	Resistor 180E 0.25W 5%	325040309
R12	Resistor 6k8 0.25W 5%	325040335
R15	Resistor 9k09 0.25W 1% Metal Film	325040145

Ref.	Description	Part No.
R16	Resistor 560E 0.25W 0.5% Metal Film	325040135
R17	Resistor 1k5 0.25W 0.5% Metal Film	325040137
R18	Resistor 4k7 0.25W 0.5% Metal Film	325040138
R19, R24, R69	Resistor 2K2 0.25W 5%	325040282
R20	Resistor 412E 0.25W 0.5% Metal Film	325040152
R21, R22, R23, R27, R29	Resistor 820E 0.25W 0.5% Metal Film	325040136
R25, R35, R40	Resistor 100k 0.25W 1% Metal Film	325040139
R30	Resistor 220E 0.25W 1% Metal Film	325040134
R32, R63	Resistor 15K 0.25W 5%	325040317
R34	Resistor 180k 0.25W 1% Metal Film	325040125
R37, R38	Resistor 22E 0.25W 1% Metal Film	325040133
R42	Resistor 2K7 0.25W 5%	999012720
SW2, SW3, SW4	Push switch	349040094
SW5	Heater Wire switch	349040099
SPK1	Audio Transducer CB-12KP	426040015
U2	IC Octal Latch 74LS373	999610004
U3	IC Micro-Processor 8085	999630012
U4	IC Ram I/O Timer 8156	999630003
	or IC Ram I/O Timer 81C55	363040415
U5	IC Hex inverter 74HC14	363040232
U6, U8	IC 8 Channel Mux. CD4051B	363040125
U7	IC Display Driver MM5451N	363040126
U9	IC 3×2 Channel Mux. CD4053B	999610003
U10	IC Quad Operation Amplifier TL074	363040124
VR1	10K Preset	327041591
VR2, VR3	5K Potentiometer	327041562
VR4	10K Preset Multiturn	327041565
VR5	50K Preset	327041590
XTAL1	Crystal 6.14 MHz	999820001
	Spacer Heater Wire Switch	693040522

8.9.2 POWER BOARD COMPONENTS: (REVISION H PCB)

Ref.	Description	Part No.
	Power PCB Assembly MR480 Complete	043040678
	Power PCB Assembly MR700/720/730 Complete	043040637
C6, C8, C32	Cap. MKT. 100nF 100V	311040028
C7, C33	Cap. Poly 100nF 250V	316040073
C25, C27	Cap. Elec. 470µF 25V	999234710
C26	Cap. Elec. 2200µF 25V	311040695
C28, C29	Cap. Elec. 10µF 25V	311040663
C30, C31	Cap. Ceramic 22nF 50V	312040116
D13, D14, D15, D16, D17, D18	Diode 1N4002	361040163
D19, D20, D21	Diode 1N4148	361040155
F1	Fuse fast acting 1 Amp (20 × 5mm)	999830001
F2	Fuse fast acting 4 Amp (20 × 5mm)	999830017
F3, F4 (MR700/720/730)	Fuse fast acting 2 Amp (20 × 5mm) for 230V	999830009

Ref.	Description	Part No.
F3, F4 (MR700/720/730)	Fuse fast acting 3 Amp (20 × 5mm) for 115V	999830012
F3, F4 (MR480)	Fuse fast acting 1.5 Amp (20 × 5mm) for 230V	999830008
F3, F4 (MR480)	Fuse fast acting 2 Amp (20 × 5mm) for 115V	999830009
Q6, Q10, Q12	Transistor BC547B	361040159
Q5	Transistor BC557B	361040156
Q7	IC 5 Volt Regulator 7805	999600003
Q8	IC 5 Volt negative Regulator 79L05	363040146
Q9, Q11	Triac BTA 08-600	999550011
U11, U12	IC Optocoupler MOC3021 or MOC3022	367060001
U13	IC Optocoupler CNY17-2	363040045
R9	Resistor 18E 0.25W 5%	325040366
R44, R46, R48, R50, R54, R58, R60, R66	Resistor 10k 0.25W 5%	325040284
R45, R55, R61	Resistor 2k7 0.25W 5%	999012720
R47	Resistor 22k 0.25W 5%	325040318
R49	Resistor 120E 0.25W 5%	325046034
R51, R52	Resistor 3k3 0.25W 5%	325040303
R53, R59	Resistor 270E 0.25W 5%	325040294
R56	Resistor 12k 0.25W 5%	325040289
R57	Resistor 180E 0.25W 5%	325040309
R64	Resistor 220E 0.25W 5%	325040296
R67	Resistor 1M 0.25W 5%	325052305
R68	Resistor 100k 0.25W 5%	325040139
	fuse clips	999840001

8.10 MECHANICAL PARTS LIST

The mechanical components listed below are referenced in accordance with the appropriate exploded diagrams (Section 5.10).

8.10.1 MR480 MECHANICAL PARTS

Ref.	Description	Part No.
1	Heater plate Assembly 150W 100V	043040701
	Heater plate Assembly 150W 115V	043040700
	Heater plate Assembly 150W 230V	043040695
2	Clamp Chamber Kit Blank (includes Gasket Ref. 5)	043040829
	Clamp Chamber Kit French (includes Gasket Ref. 5)	043040830
	Clamp Chamber Kit German (includes Gasket Ref. 5)	043040831
	Clamp Chamber Kit English (includes Gasket Ref. 5)	043040834
3	Spring Mounting	662040040
4	Guard Chamber Kit	043040709
5	Gasket Clamp	336060126
6	PCB Assembly MR480 Control No Eprom	043040679
7	Case Front Kit - Specify Model Number eg "Case Front Kit MR480JHB"	
8	Knob Control	281150393
9	Case Door Right	693040473
10	Switch Harness Assembly	043040697
11	PCB Assembly MR480 Power Complete	043040678
12	Case Foot	693040478
13	Case Door Left	693040472

Ref.	Description	Part No.
14	Mains Cord MR700 USA Hosp Grade 3.3m UL	095428157
	Mains Cord MR700 Australian Clear Plug 3.3m	095428159
	Mains Cord MR700 No Plug 3.3m	095428160
	Mains Cord MR700 French 230V No Plug 3.3m	095428203
	Mains Cord MR700 Danish Plug 230V 2.9m	095428204
	Mains Cord MR700 USA Hosp Grade 2 ft 90deg Plug UL	095428205
	Mains Cord MR700 UK Plug 230V Fused 3.3m	095428214
	Mains Cord MR700 Schuko Plug 230V 3.3m	095428217
	Mains Cord MR700 Schuko Plug 230V 3.3m Earth Lug	095428226
15	Screw #8 × 1/2" Pan Phil TY25 S/S	614040120
16	Case Body Kit - Specify Model Number eg "Case Body Kit MR480JHB"	
17	Washer M6 Wavey	622040140
18	Nut M6 Nyloc ZPS	621040524
19	Bracket Transformer	641040706
20	Screw M4 × 8 Pan Phil ZP Taptite	614040117
21	Bracket Mounting 30mm × 5mm Tongue	693040491
22	Screw M6 × 25 Csk Allen S/S	614040208
23	Transformer Assembly MR480 230V	043040551
	Transformer Assembly MR480 115V	043040850
24	Screw M4 × 14 Pan Phil Taptite YChr	614040223
25	Clamp Cord Small	693040476
	Clamp Cord Large	693040477
26	Spacer Hose Heater Cord	336060064
27	Washer M6 Ext Fan Disk Lock Zn/St	622041013
28	Screw M6 × 16 Allen S/S Button Head	614040230
	Lug Earth	345060096
29	Probe Socket Harness Assembly	043040698
30	Screw M3 × 5 Taptite Pan Phil YChr	614040116
31	Washer Lock M4 Int Zn/Pl	622040130

8.10.2 MR730/720/700 MECHANICAL PARTS

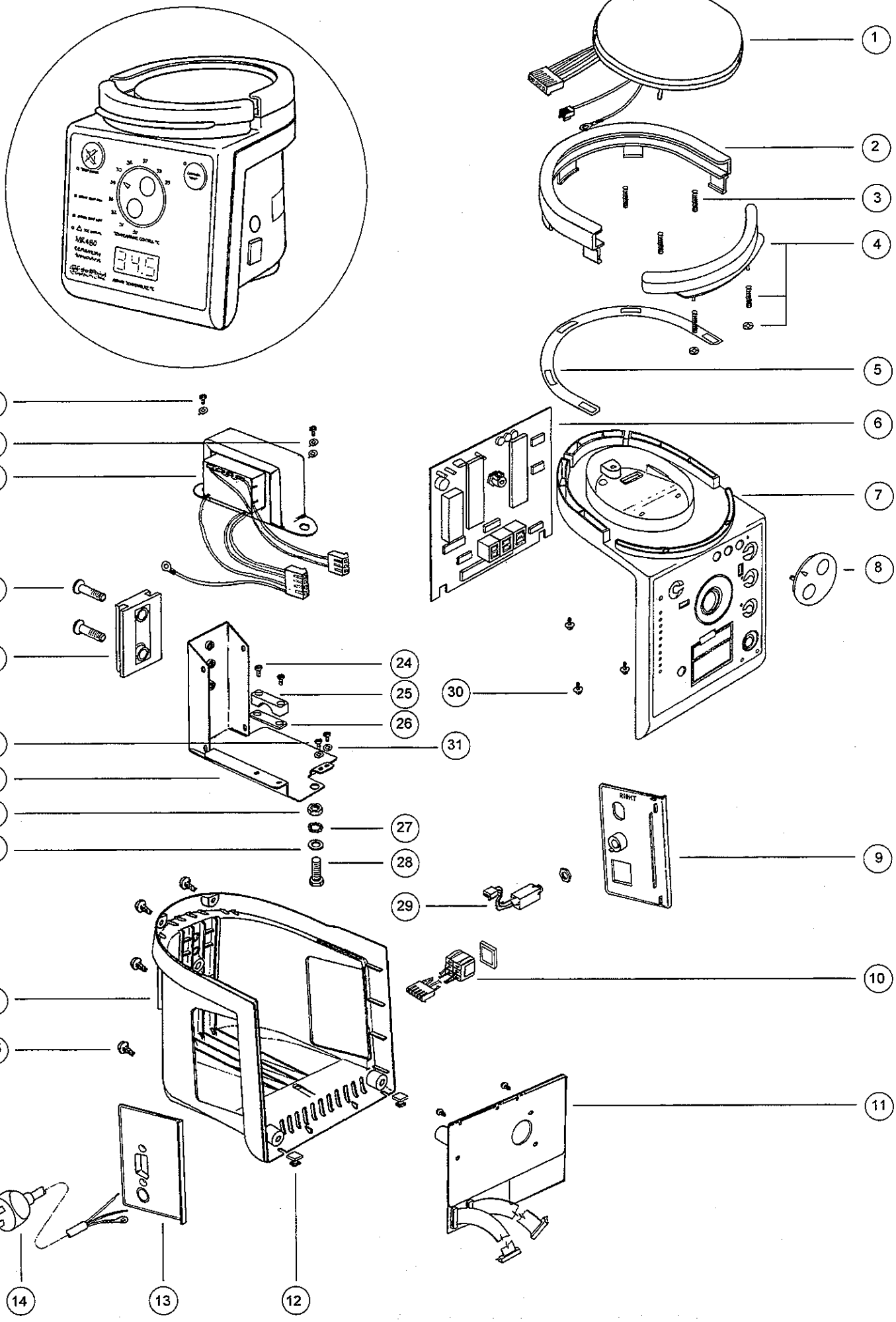
Ref.	Description	Part No.
1	Heater plate Assembly 150W 100V	043040701
	Heater plate Assembly 150W 115V	043040700
	Heater plate Assembly 150W 127V	043040839
	Heater plate Assembly 150W 230V	043040695
2	Clamp Chamber Kit Blank (includes Gasket Ref. 5)	043040829
	Clamp Chamber Kit French (includes Gasket Ref. 5)	043040830
	Clamp Chamber Kit German (includes Gasket Ref. 5)	043040831
	Clamp Chamber Kit English (includes Gasket Ref. 5)	043040834
3	Spring Mounting	662040040
4	Guard Chamber Kit	043040709
5	Gasket Clamp	336060126
6	PCB Assembly MR700 Control No Eprom	043040633
	PCB Assembly MR720 Control No Eprom	043040677
	PCB Assembly MR730 Control No Eprom	043040675
7	Case Front Kit Specify Model Number eg "Case Front Kit MR720JHB"	
8	Knob Control	281150393
9	Knob Offset	693040475
	Knob Fixed Offset	693040483
10	Case Door Right	693040473
11	Switch Harness Assembly	043040697
12	PCB Assembly (MR730/720/700) Power Complete	043040637
13	Case Foot	693040478
14	Harness Assembly DB9 (RS232)	043040699

Ref.	Description	Part No.
15	Case Door Left	693040472
16	Mains Cord MR700 USA Hosp Grade 3.3m UL	095428157
	Mains Cord MR700 Australian Clear Plug 3.3m	095428159
	Mains Cord MR700 No Plug 3.3m	095428160
16	Mains Cord MR700 French 230V No Plug 3.3m	095428203
	Mains Cord MR700 Danish Plug 230V 2.9m	095428204
	Mains Cord MR700 UK Plug 230V Fused 3.3m	095428214
	Mains Cord MR700 Schuko Plug 230V 3.3m	095428217
	Mains Cord MR700 Schuko Plug 230V 3.3m Earth Lug	095428226
17	Screw #8 × 1/2" Pan Phil TY25 S/S	614040120
18	Case Body Kit Specify Model Number eg "Case Body Kit MR730JHB"	
19	Washer M6 Wavey	622040140
20	Nut M6 Nyloc ZPS	621040524
21	Bracket Transformer	641040706
22	Screw M4 × 8 Pan Phil ZP Taptite	614040117
23	Screw M4 × 50 Pan Phil ZP	614040214
24	Nut M4 Nyloc ZPS	621040517
25	Bracket Mounting 30mm × 5mm Tongue	693040491
26	Screw M6 × 25 Csk Allen S/S	614040208
27	Insulator Transformer	331040158
28	Transformer Assembly (MR700 Series) 100V	043040929
	Transformer Assembly (MR700 Series) 115V	043040928
	Transformer Assembly (MR700 Series) 127V	043040931
	Transformer Assembly (MR700 Series) 230V (double insulated)	043040932
29	Tape Foam Adhesive 3mm × 10mm × 60mm	254040059
30	Screw M4 × 14 Pan Phil Taptite YChr	614040223
31	Clamp Cord Small	693040476
	Clamp Cord Large	693040477
32	Spacer Hose Heater Cord	336060064
33	Washer M6 Ext Fan Disk Lock Zn/St	622041013
34	Screw M6 × 16 Allen S/S Button Head	614040230
	Lug Earth	345060096
35	Screw M3 × 5 Taptite Pan Phil YChr	614040116
36	Washer Lock M4 Int Zn/Pl	622040130
37	Harness J10-Hose & Socket Heater Wire Kit	043040961
38	Probe Socket Harness Assembly	043040698

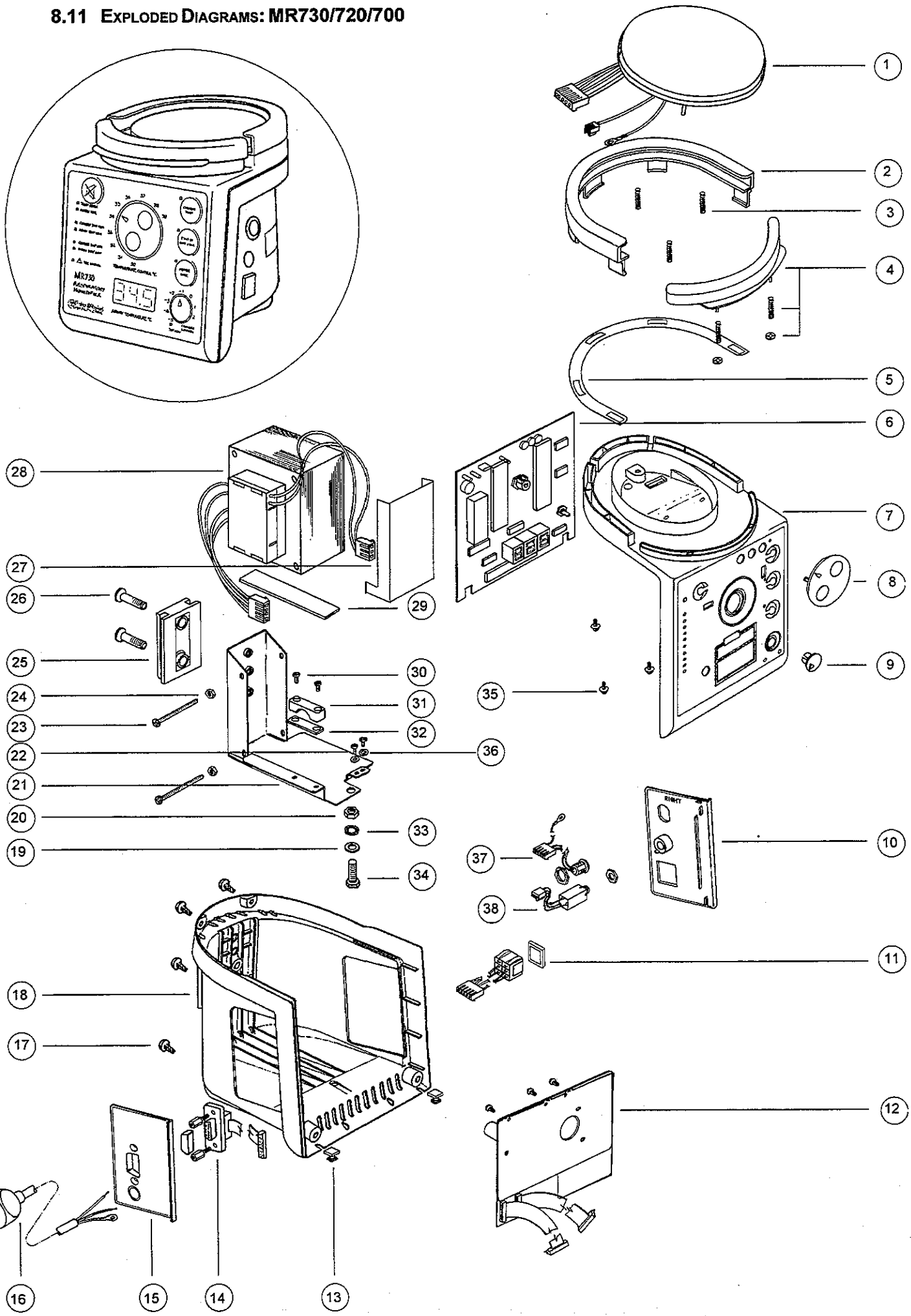
8.10.3 HEATER PLATE ASSEMBLY PARTS (MR730/720/700/480)

Ref.	Description	Part No.
1	Insulator Heater Plate	331040154
2	Screw M4 × 8 Pan Phil Taptite	614040117
3	Cover Element Plate	641040707
4	Element Assembly 230V 150W	043040893
	Element Assembly 127V 150W	043040833
	Element Assembly 115V 150W	043040894
	Element Assembly 100V 150W	043040895
5	Screw M3 × 5 Taptite Pan Phil YChr	614040116
6	Insulator Element	331040114
7	Thermistor and Harness Assembly	095428156
8	Plate Heater	043040875
9	Harness Heater Plate - Earth	095428154
10	Washer Lock M4 Int Zn/Pl	622040130
11	Thermostat 118 Degree Centigrade	349040052
12	Harness J7 - Heater Plate	095428279

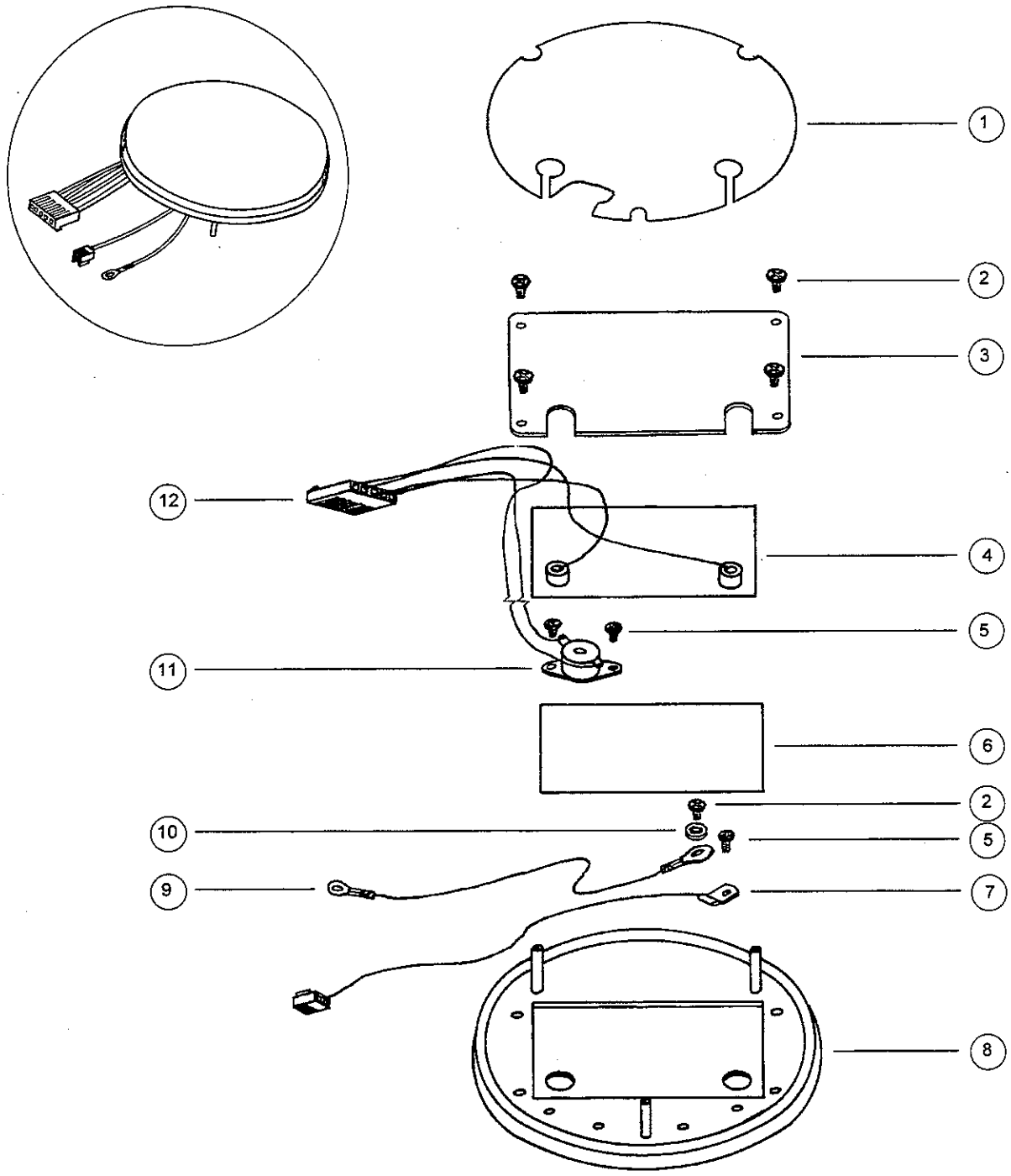
8.11 EXPLODED DIAGRAMS: MR480



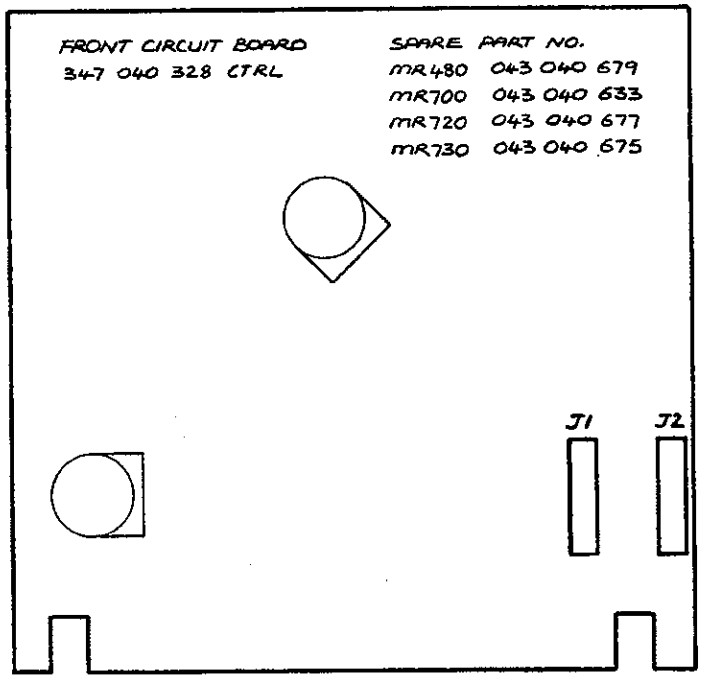
8.11 EXPLODED DIAGRAMS: MR730/720/700

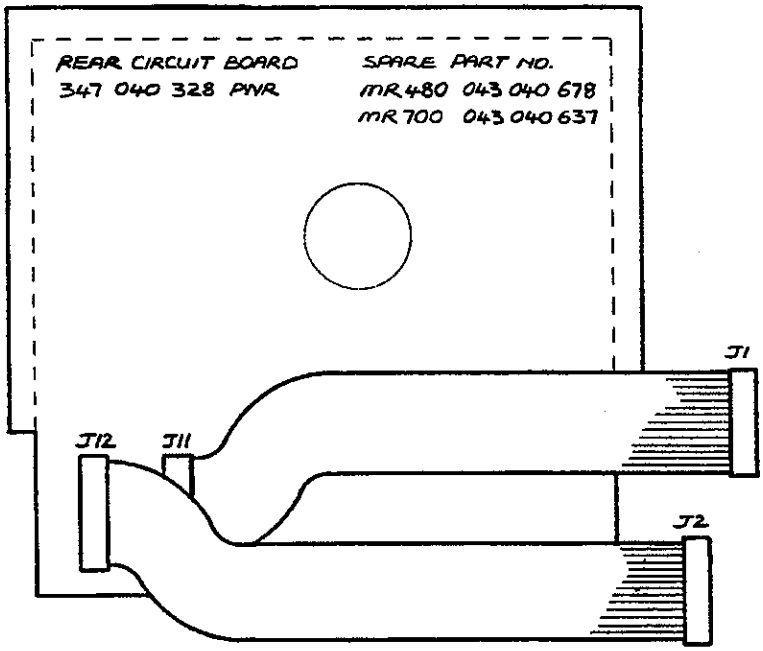


8.12 Exploded Diagrams: Heater Plate Assembly MR730/720/700/480 (Inverted View)

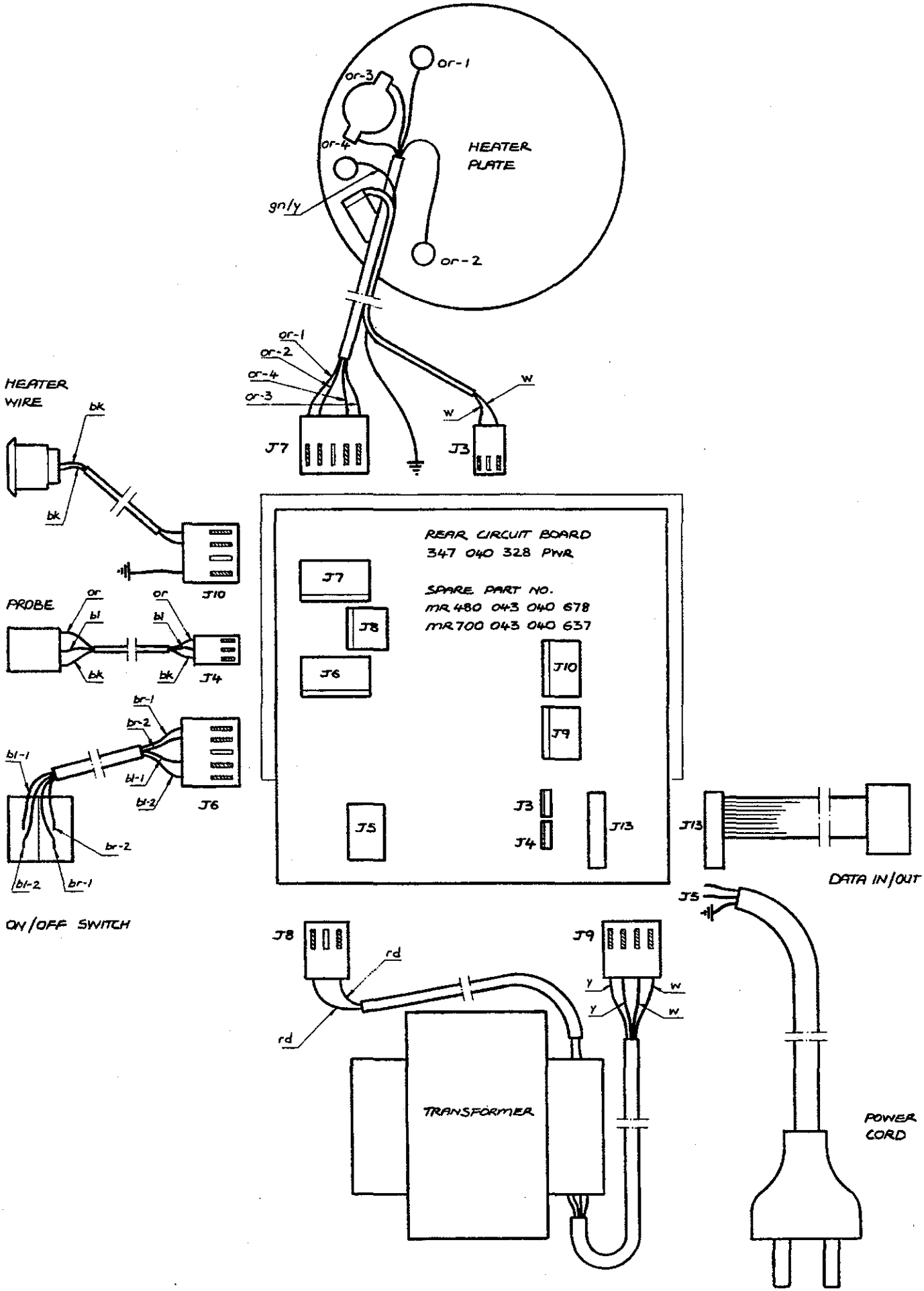


8.13 PCB Identification Diagram





8.14 Power PCB Harness Connection Diagram



9.0 PRODUCT CHANGE HISTORY

This change history details changes which may have significance for servicing. It does not include all changes. Refer also to change panel on circuit diagrams, and Appendices at back of this manual.

DATE	CHANGE NUMBER	FIRST SERIAL NUMBER AFFECTED	COMMENTS
29/06/92	1056	92XXAAA02786	Introduction of Version 2.0 Software. • Changes from Version 1.0 are: • Delay on chamber temperature display. • Sensitivity of control knobs increased. • Auto standby mode for MR720. (Note: this change not introduced on AF- and AG- models until serial number 93XXAAA01818, excluding AGM models.)
03/08/92	1019	92XXAAA05495	Enhanced 41 °C calibration - with introduction of Rev F PCB. Note: this change not introduced on AF- and AG- models until serial number 93XXAAA01818.)
22/01/93	1363	93XXAAA01818	Introduction of Version 2.0 Software on AF- and AG- models. Note: this change not introduced on AGM models.
25/01/93	1100	93XXAAA02582	C7 added, R57 changed to 390E from 1K2.
7/06/94	1992	9473JES08020 (1)	Version 3.0 software started. Changes from version 2.0 are: • Standby mode times out after 30 minutes (was 20) • Low temperature alarm in warm up mode activated sooner. • Set low indicator alarm changed • Display during A to D calibration improved
12/10/94	2088	9473AGU17549	AGU AND AGT Models to version 3 software
22/08/94	2079	9473AGM14257	MR730AGM to version 3 software
15/12/94	2161	9473GES22496	MR730GES to version 3 software
17/02/95	2313	9573GEU03084	MR730GEU to version 3 software
3/07/95	2469	9541JHB10757	Electroless nickel plating on heater plate started.
9/08/95	2433	9573JHB12155	Changed recommended settings on front fascia.
1/10/95	2443	9573AEA15923	Introduction of Rev H PCB

Notes:
(1) All countries except Japan and Germany

9.1 COMPATIBILITY OF SOFTWARE AND HARDWARE VERSIONS

Care has been taken to ensure that the software is downwards compatible with the hardware, as long as the two PCB's are kept together as a set. So, if a revision D power or control PCB needs to be replaced, then both PCB's need to be upgraded together to Revision H to ensure correct performance. See section 7.3 for details of upgrade kits. Revision F and H PCB's can be replaced individually.

9.2 MODEL NUMBER EXPLANATION

eg for MR730AEU:	**MR730**	**A**	**E**	**U**
	Model Type	Voltage	Language	Customer Specific

First Letter	Voltage	Second Letter	Front Panel Language	Side Panels Language
A	230V ± 25V	D	English	English/German
P	127V ± 10V	E	English	English/French
J	115V	F	French	English/French
G	100V ± 10V	G	German	English/German
		H	English	English/Spanish
		J	Japanese	English/Japanese
		L	Italian	English/Italian
		S	Spanish	English/Spanish

9.3 SERIAL NUMBER EXPLANATION

92	XX	AAA	XXXXX
YEAR	MODEL	CODE	SERIAL NUMBER
	41 MR410	Three-letter code	
	48 MR480	is as per above	
	70 MR700	specification.	
	72 MR720		
	73 MR730		

APPENDIX A

A1 CALIBRATION MODE

Entry to the calibration mode is made by holding down the 'Chamber Temp' button and turning on the Mains Power switch.

After a two second delay the display should show '-1-'.

On releasing the 'Chamber Temp' button the display will show the humidifier model number (730/720/700 or 480).

The 'Chamber Temp' button is now used to step between functions as shown below.

-1-	Model number display.
-2-	Software version display.
-3-	Traceability number.
-4-	41.0 °C comparator calibrate. VR4
-5-	ADC zero calibrate. VR5

On pushing the 'Chamber Temp' button the display will show the present function number then after a one second delay step to the next higher function number, where if the 'Chamber Temp' button is then released then that function is entered

The calibration mode will time out (to normal operating mode) 5 minutes after the last 'Chamber Temp' button push. The normal exit mode is to turn the humidifier mains power switch off then on again.

For details on 41.0°C and ADC zero calibration procedures refer section 5.3

A2 ENGINEERING MENU

To enter the engineering menu push the Mute and 'Chamber Temp' buttons simultaneously and hold for at least 1.5 seconds. At this time the display will show SET (for set temperature display) as a pointer to that function and on release of the 'Chamber Temp' button the display will show the set temperature control temperature setting to one decimal place. To maintain this display, the Mute button should be kept depressed. If the Mute is released, the display will revert to normal operation in about 6 seconds.

The display can be stepped through the engineering menu in two ways.

1) If the Mute is held down constantly the functions can be selected sequentially by pressing the 'Chamber Temp' until the display changes to the next function pointer, where if the 'Chamber Temp' button is then released the display will show that function.

2) Releasing the mute button the humidifier will automatically step through the menu until either the mute button is pressed whereupon the display will show that function or if 6 seconds has elapsed and the humidifier will display 'End'.

If 'End' appears on the display and the Mute button is momentarily pushed the time out will be inhibited and the stepping through the function pointers continued.

A2.1 ENGINEERING DISPLAY FUNCTIONS: HEATER WIRE MODE

SET	Set temperature display (°C)
OFF	Offset temperature display (Chamber Control) (°C)
Edc	Heater wire duty cycle (%)
Cdc	Heater plate duty cycle (%)
hP	Heater plate temperature (°C)
L	Programming link status. (L1, L2, ... L6)
CP	Compare probes (Probe test)
Ei	Heater wire integral
Ti	Heater plate integral

A2.2 ENGINEERING FUNCTIONS: NON HEATER WIRE MODE

SET	Set temperature display (°C)
dc	Heater plate duty cycle (%)
hP	Heater plate temperature (°C)
L	Programming link status
CP	Compare probes (Probe test)
i	Heater plate Integral

A2.3 INTEGRAL DISPLAY

The integral is an error offset signal which constantly accrues to compensate for the temperature difference between the set control and probe. It is displayed in the 'Ei' and 'Ti' engineering functions in hexadecimal notation, ie. the count progresses from 0 to 9 then continues through A b c d E F before cycling back to 0. A negative integral is indicated by the three 'decimal points' in the display being lit. The magnitude of the integral is + or - EFF (+ or - 3839 in decimal notation).

A3 PROGRAMMING CONTROL OPTIONS

The following options can be enabled by joining the pads on the control PCB as shown.

x = don't care.
1 = link.
0 = no link.

L1	L2	L3	
x	x	0	ISO draft standard audio alarm.
x	x	1	Gliding tone audio alarm.
1	0	x	50 °C maximum temperature Heater Plate.
1	1	x	80 °C maximum temperature Heater Plate.
0	1	x	90 °C maximum temperature Heater Plate.
0	0	x	110 °C maximum temperature Heater Plate.

The state of the above links can be displayed in the engineering menu ('L').
The factory default settings are for the ISO alarm and 110 °C heater plate, except MR720 which has an 80 °C heater plate.

A4 GLOSSARY OF ABBREVIATIONS

EOH	The End Of Hose temperature.
OFFSET	The temperature difference of the TOP from the SET.
SET	The temperature Set potentiometer. Sets the controlling temperature of the EOH.
TOP	The temperature at the Top of the humidification chamber.
RSD	Remote Shut Down.

A5 ERROR CODES

During operation, if the microprocessor U3 does not receive an expected interrupt within a given time window an error condition will be flagged. In particular the RST6.5 interrupt which marks the termination of the integration ramp from U10-E and also controls the counter in U4 will in the event of the count exceeding certain limits generate an error message. When the count recorded by U4 is less than 256 an underflow error is generated and should the count exceed 16128 an overflow error is indicated.

Some of the error indications which can be displayed on the MR700 Series digital display are listed below, with an explanation of the possible cause.

Error Messages

Ec	Checksum error (possible failure of U1 EPROM).
En	Memory test error (possible failure of U4 RAM).
EXx	Where X = 0 through 7, indicating multiplexer stage where error occurred. Where x = o or u, indicating ADC overflow error or underflow error, at the indicated multiplexer stage.
b-1	The Mute button is on at turn on or has been on for > 5 minutes.
b-2	The Standby button is on (see b-1 above)
F-2	The Heater Wire fuse, F2 is open circuited.
---	Temperature sensor probe fault (see sec.1.6.2).

The following errors may occur during the software-driven shorted probe cable test. If the errors do not persist they do not necessarily indicate a faulty probe assembly. It is because of conflicting results during the test that a definite conclusion cannot immediately be made.
Errors EP2 to EP4 can be caused for example by abnormal high differential temperatures on the two thermistors or by rapidly changing input temperatures.

EP1	Hardware fault; Q13 short not effective.
EP2	Low probe temperature (~0 °C).
EP3	High probe temperature (~70 °C).
EP4	Partial short between the active probe cable conductors.

A6 MR700 SERIES HUMIDIFIER SERIAL DATA INTERFACE

A6.1 SERIAL DATA FORMAT

1 byte	: (semi colon) Marks beginning of data record.
4 bytes ASCII	Temperature control setting
4 bytes ASCII	Airway temperature.
4 bytes ASCII	Chamber temperature.
4 bytes ASCII	Heater Plate temperature.
4 bytes ASCII	Heater wire duty cycle.
4 bytes ASCII	Heater plate duty cycle.
4 bytes ASCII	Chamber Control setting .
4 bytes *	Status information. (1*ASCII 3*binary bytes)
2 bytes	CR, LF. (Marks end of data record)

Between each of the above lines there is approximately a 50 ms pause before the next line is transmitted. The complete data record is repeated every 500 - 600 ms (500ms on a 60Hz supply, 600ms with 50Hz). Data format is RS232 levels, no handshaking, 9600 baud, 8 bits, no parity, with one stop bit.

Between the semi colon and the line feed there are eight, 4-byte packets of information as shown above. In each case the first byte of the packet contains an identification letter from 'a' through 'h' in ASCII.

The format of the 3 bytes following the ASCII I.D. is as shown below.

I.D. a - SET temperature.
I.D. b - Airway temperature.
I.D. c - Chamber temperature.

Range 05.0 - 80.0°C. decimal point is assumed between 1st and 2nd digits.

I.D. d - Heater Plate temperature.

Range 14.0 - 99.9°C decimal point assumed. 100 - 135°C no decimal point.

I.D. e - Heater Wire duty cycle.
I.D. f - Heater Plate duty cycle.

Range 0 - 100 %

I.D. g - Chamber Control Setting.

Range -5.0 to +2.0 decimal point assumed. Plus or minus sign in leading ASCII byte.

I.D. h - Status information.

The ASCII I.D. is followed by three binary bytes giving alarms and error information.
See format below.

The data record as received should start with an ':' and end with an 'LF'. Under abnormal operating conditions however (when there are 'E' messages in the display) some or all of the above packets 'a' to 'g' can be missing. The status information packet 'h' will always be present (as long as the micro is running) and will show the error condition.
When there are error messages in the display bit 6 of the last status byte will be set high indicating a fatal error condition.

A6.2 STATUS INFORMATION

First Byte

Bit0 Probe disconnect LED
Bit1 Heater Wire disconnect LED
Bit2 Airway Temp Low LED
Bit3 Airway Temp High LED
Bit4 Chamber Temp Low LED
Bit5 Chamber Temp High LED
Bit6 Chamber Temp Button LED
Bit7 Always set high

Second Byte

Bit0 Standby button LED
Bit1 Heater Wire operation LED
Bit2 Remote Shut Down request acknowledge
Bit3 Set Low LED
Bit4 Audio alarm muted
Bit5 External request acknowledge Heater Wire operation
Bit6 External request acknowledge No Heater Wire operation
Bit7 Always set high

Third Byte

Bit0 Heater Plate ON
Bit1 Heater Wire ON
Bit2 Always low
Bit3 Always low
Bit4 See table
Bit5 See table
Bit6 Fatal error
Bit7 Always set high

Bit4	Bit5	Model
0	0	MR480
1	0	MR700
0	1	MR720
1	1	MR730

A6.3 REMOTE STANDBY

A constant high input (pin 2 DB9 connector >1.5 volts) shuts down the humidifier. Low or open circuit input enables the humidifier. An RSD request signal puts the humidifier into the standby mode; i.e. No low alarms active, controlled 40.0 °C heater plate and 15% Heater Wire duty cycle. On removal of an RSD request the humidifier enters the warm up mode. On the MR730/720 models the standby LED is also turned on (not flashing).

A6.4 SERIAL DATA INTERFACE CONNECTOR

A DB9 connector on the side of the humidifier provides the interface connections.

pin 2 Remote shut down input (Serial in).
pin 3 Serial Data output.
pin 5 Humidifier Earth.
pin 7 +5 volt (30 mA max)

A7 REVISION F & H PCB SCHEMATIC DIAGRAMS

Components marked with an * on the Revision F & H Schematic Diagrams (ie LED12, R62) provide an optional feature and may not be included in units containing a Revision F or H PCB.

APPENDIX B

B1 RECOMMENDED MAINTENANCE SCHEDULE

The MR700 series humidifiers operating software continually monitors the performance characteristics of the humidifier reporting any errors and in the event of a fatal error terminates operation in a fail safe mode. For this reason preventative maintenance of the humidifier need only be performed at extended intervals.

The following list of routine checks are recommended to be performed at the intervals stated.
For each maintenance check fill out a checklist, as given in section B2.

B1.1 Monthly.

Perform the following:

a) Check temperature probe for damage to sensor tips, abrasion of the cable or tarnishing of electrical contacts. Clean with alcohol on a swab or replace as necessary.

b) Remove and check the reusable hose heater wire (if fitted) for kinks and abrasions. Replace if necessary.

c) Check heater wire connector for damage to cable and both end plugs. Check for correct coupling of the plugs with their respective sockets on the heater base and heater wire assembly.

d) Check humidifier power cable for damage and replace as necessary.

e) Plug probe and heater wire (if fitted) into heater base and switch on. Observe correct operation of power up procedure. Check for no immediate alarms and correct display of ambient temperature. Continue to run for at least 30 seconds by which time all the relevant internal tests will have been completed. Switch off.

B1.2 Three Monthly.

Perform a temperature probe test as outlined in section 6.4.

B1.3 Annually.

Execute a performance check appropriate to the humidifier model as detailed in section 6.0.
Carry out Electrical Safety checks as per Appendix B2.

B1.4 Annually Or In Accordance With Relevant Country Regulations.

Carry out Electrical Safety checks, see section B2.

B2 RECOMMENDED MAINTENANCE SCHEDULE CHECKLIST

(PHOTOCOPY AND FILE IN MAINTENANCE RECORDS)

Type of service check: MONTHLY / THREE MONTHLY / SIX MONTHLY / ANNUAL (CIRCLE ONE)

Humidifier Serial Number:_____ Date: _____

Step	Method	PASS	FAIL
Monthly			
a) Check Temperature Probe	Refer Appendix B1.1	[ ]	[ ]
b) Check Reusable Heater Wire	Refer Appendix B1.1	[ ]	[ ]
c) Check Heater Wire Connections	Refer Appendix B1.1	[ ]	[ ]
d) Check Power Cable	Refer Appendix B1.1	[ ]	[ ]
e) Perform Self-Test	Refer Appendix B1.1	[ ]	[ ]
Three Monthly			
Perform Temperature Probe Test	Refer Section 6.4	[ ]	[ ]
Annually			
Performance Check	Refer Section 6.0	[ ]	[ ]

Electrical Safety Checks - as required and after any servicing

Earth resistance test

Measure the resistance from the earth pin on the mains plug to:

a) The heater plate	[ ]	[ ]
b) The earth stud on the base of the humidifier	[ ]	[ ]

Should be 0.2 Ohms maximum

Insulation resistance test

Use a 500V DC tester to measure the resistance from the phase pin on the mains plug to:

a) The heater plate	[ ]	[ ]
b) The earth stud on the base of the humidifier	[ ]	[ ]

Should be 10 MegaOhms minimum

Earth Leakage test

This has to be measured using an electrical safety tester designed as per UL544 or IEC601. Measure earth leakage with the earth probe of the tester on the heater plate. Earth leakage current is measured at normal operating voltage and frequency of supply.

Should be 0.5mA maximum in no fault condition	[ ]	[ ]

Signature:_____

APPENDIX C

C1 TROUBLESHOOTING GUIDE FOR THE MR700 SERIES RESPIRATORY HUMIDIFIERS

This is a guide to possible corrective action in the case of an humidifier alarm condition or malfunction. It is written for the MR730, MR720, MR700 and MR480 humidifier models with the MR730 and MR720 in the heater wire on mode. Parts of this guide would not be applicable for the MR480, MR730 and MR720 in the heater wire off mode.

Unless the cause and immediate effects of an alarm condition are understood and assessed to be of no hazard to the patient, the humidifier should be immediately switched off and removed from the patient circuit.

Low temperature.

a. Temperature less than desired, no alarm.

- Humidifier warming up - wait for a few minutes.
- Standby mode switched on
  - push 1 sec to disable standby.
  - wait 20 minutes (30 minutes for version 3.0).
- Check position of temperature probe in the circuit.

b. Airway temperature low alarm activated.

- Gas flow stopped or interrupted - enter standby mode or turn humidifier off until gas flow resumed. Note: Gas flow must be resumed before coming out of standby mode.
- Set temperature increased by more than 2 °C - wait for temperature to rise.
- Temperature probe not in probe housing - fit temperature probe.
- Gas flow rate too low - increase gas flow to more than 2 litres per minute.
- Too much distance between end of heater wire and temperature probe - use longer heater wire or shorten inspiratory hose so that distance is between 25 and 100 mm, ideally 30 mm (1-2").

c. Chamber temperature low alarm activated.

- Poor thermal contact between base of chamber and heater plate - check that chamber base and heater plate are clean, smooth and flat. If necessary clean or replace. Humidification chambers which are not manufactured by Fisher & Paykel may not be suitable.
- Temperature probe not inserted at chamber outlet - fit temperature probe correctly.
- Heater element needs replacement - send for repair.
- Gas flow rate too high for chamber - use correct chamber. Refer to the operating instructions for the type of chamber used.

High temperature.

a. Airway temperature high alarm activated.

- Sudden increase in gas flow - wait for `temperature to fall.
- Heater wire too close to temperature probe - use shorter heater wire or lengthen inspiratory hose so that distance is between 25 and 100 mm, ideally 30 mm.
- Set temperature lowered by more than 2 °C (4 °C for MR720) - wait for temperature to fall.
- Temperature probe located inside incubator or under radiant warmer - use correct circuit configuration.

b. Chamber temperature high alarm activated.

- Humidification chamber outlet temperature too high - remove humidifier from breathing circuit and have humidifier checked.
- No water in the chamber
- Change in the gas flow

Temperature fluctuating, high and low temperature alarms.

- Ventilation rate too low or too erratic for proper humidifier temperature control. Ventilation rates below about 6bpm or of a highly erratic nature, may affect the stability of the temperature control.
- Humidifier temperature control influenced by external heating or cooling such as air conditioner - shield breathing circuit from external influence.
- Check temperature probe position in the circuit.

Excessive water in circuit.

- Water trap not at the lowest point of the circuit.

Excessive water in inspiratory circuit due to rainout.

- Chamber control set too high - reduce setting. MR700, 720, 730.
- Heater wire too close to temperature probe - increase distance from heater wire to temperature probe so that the distance is between 25-100mm, ideally 30mm (1-2").
- Temperature probe located inside incubator or under radiant warmer - use correct circuit configuration.
- Inspiratory circuit being cooled by air conditioner - shield circuit from air conditioner.

Excessive water in expiratory circuit due to rainout.

- Expiratory heater wire required. Use a dual heater wire adaptor.

Excessive liquid water ejected from humidification chamber into circuit.

- Humidification chamber filled beyond maximum water level line - reduce water lever.
- Maximum permissible peak flow rate of humidification chamber has been exceeded - use correct chamber. Refer to the operating instructions for the type of chamber used.
- Humidifier chamber tilted.

Low humidity.

- Chamber control set too low - increase setting. MR700, 720, 730.
- No water in humidification chamber - fill chamber.
- Check chamber temperature via chamber button - if low check:
  - heater plate temperature setting on display when humidifier is switched on.
  - that chamber base and heater plate are smooth and flat.
  - Humidification chambers which are not manufactured by Fisher & Paykel may not be suitable.
- Gas flow rate too high for chamber - use correct chamber. Refer to the operating instructions for the type of chamber used.

Temperature probe alarm.

Temperature probe alarm, "- - -" on temp display.

- Temperature probe unplugged - check connection.
- Temperature probe plug dirty - clean plug.
- Temperature probe faulty - replace temperature probe.

Heater wire alarm.

a. Heater wire alarm, temperature still displayed.

- Heater wire unplugged - check connection.
- Heater wire broken - replace heater wire.
- Heater wire switch turned off - but heater wire connected.
- Heater wire switch turned on - but heater wire not connected, turn off.

b. Heater wire alarm, F2 on temperature display.

- Internal fuse blown - send for repair.
- Check calibration of the 41 °C comparator.

No temperature display.

a. No temperature display, no alarm lights.

- Humidifier voltage rating incorrect - select correct voltage rated unit.
- Humidifier power cord not connected to mains supply - connect to mains.
- Humidifier power switch not turned on - turn on.
- Overheat protector operated - send for repair.
- Transformer over heat protector operated - send for repair.

b. No temperature display, "see manual" indicator on.

- Humidifier failed self test - send for repair.

Breathing circuit leak.

- Check all circuit connections, check that humidification chamber water filler stopper is in place or water bag connected. Check that temperature probes are fitted correctly.

Error code on temperature display.

- Humidifier microprocessor failed self test - send for repair.

External water leak.

a. External water leak with reusable chamber.

- Check that chamber O-ring is clean and correctly fitted.
- Check that O-ring is not damaged - replace if necessary.

b. External water leak with disposable chamber.

- Disposable chamber in use for too long - replace chamber.

An alarm LED flashing.

- No audible sound - mute switch has been pressed - wait three minutes.

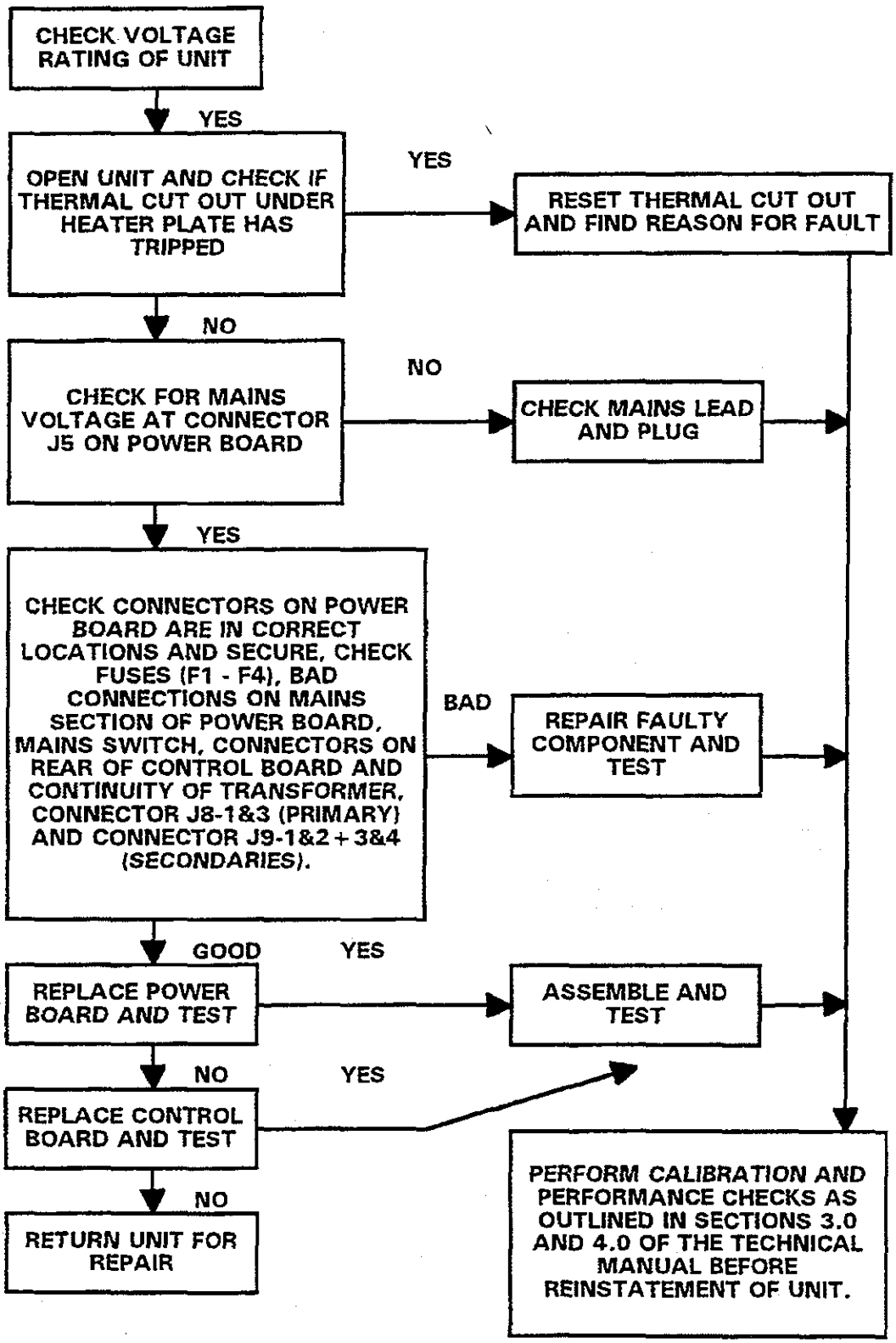
Standby LED flashing.

- Humidifier in standby mode
  - push 1 sec to disable standby.
  - wait 20 minutes (30 minutes for version 3.0).

Set Low LED on.

- Chamber control or airway temperature control setting too low - readjust. Refer to humidifier operating manual.

C2 MR700 Series Fault Flow Chart For No Go Condition


CHECK VOLTAGE RATING OF UNIT
YES
OPEN UNIT AND CHECK IF THERMAL CUT OUT UNDER HEATER PLATE HAS TRIPPED
YES
RESET THERMAL CUT OUT AND FIND REASON FOR FAULT
NO
CHECK FOR MAINS VOLTAGE AT CONNECTOR J5 ON POWER BOARD
NO
CHECK MAINS LEAD AND PLUG
YES
CHECK CONNECTORS ON POWER BOARD ARE IN CORRECT LOCATIONS AND SECURE, CHECK FUSES (F1 - F4), BAD CONNECTIONS ON MAINS SECTION OF POWER BOARD, MAINS SWITCH, CONNECTORS ON REAR OF CONTROL BOARD AND CONTINUITY OF TRANSFORMER, CONNECTOR J8-1&3 (PRIMARY) AND CONNECTOR J9-1&2 + 3&4 (SECONDARIES).
BAD
REPAIR FAULTY COMPONENT AND TEST
GOOD
YES
REPLACE POWER BOARD AND TEST
ASSEMBLE AND TEST
NO
YES
REPLACE CONTROL BOARD AND TEST
NO
RETURN UNIT FOR REPAIR
PERFORM CALIBRATION AND PERFORMANCE CHECKS AS OUTLINED IN SECTIONS 3.0 AND 4.0 OF THE TECHNICAL MANUAL BEFORE REINSTATEMENT OF UNIT.